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AN INVESTIGATION INTO THE RELATIONSHIP BETWEEN BODY DIRECTIONALITY, LETTER DIRECTIONALITY AND READING ACHIEVEMENT OF GRADE ONE CHILDREN

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "An Investigation into the Relationship between Body Directionality, Letter Directionality and Reading Achievement of Grade One Children" submitted by Brian Thomas Twohig in partial fulfillment of the requirements for the degree of Master of Education.

ABSTRACT

The task of accurate letter discrimination appears to be a major factor in the beginning stages of the reading process. The purpose of this study was to examine the relationship of a child's ability to discriminate alphabetic letters which differed on a number of directional dimensions (left-right, vertical, combination of both) and his level of reading achievement. It was further proposed to study the child's ability to discriminate the directionality of letters and its relation to his perception of directionality in terms of his own body.

The sample consisted of sixty grade one children who were of at least average I. Q., with an equal distribution over sex and reading achievement level.

Each child was administered the Keystone Visual Screening Test to ensure an adequate level of visual proficiency. The SRA Primary Mental Abilities (K - 1) was used as an estimate of I. Q. while the Neale Analysis of Reading Ability was administered to assess reading achievement.

The Body, Letter, Word and Sentence Directionality tests were specially constructed for this study. The Body Directionality Test was a test of subjective spatial discrimination, in the sense that it measured a child's ability to discriminate directions (i.e., left-right, up-down, front-back) with reference to his own body. The Letter, Word and Sentence tests were measures of objective spatial discrimination ability and tested a child's ability to discriminate the directional

orientation of alphabetic letters transformed over various dimensions (i.e., left-right, vertical and a combination of these). A time score was obtained for the latter three tests.

Findings showed a significant correlation existed between a child's scores on discrimination tests, the time taken to complete the tests and his level of reading achievement. Findings further revealed that scores on the discrimination tests tended to decrease from the discrimination of directionality with reference to one's own body through to alphabetic letters in isolation, within words and finally within the context of a sentence. The Sentence Directionality Test appeared to be the best predictor of reading success for grade one children in the latter part of their first year of instruction.

The low reading achievement group scored consistently below the average and high reading achievers on all variables. Not only did the low achievers score consistently lower, but they also made a much greater proportion of different kinds of directional errors (left-right, vertical and a combination of these) as opposed to the average and high achievers who tended to make errors on left-right dimension only.

Finally, correlations between the directionality tests and the I. Q. total as well as the subtest scores suggested that directional discrimination ability as measured by the present tests appears to be more highly related to a general intelligence factor than to any of the specific factors as measured by the SRA Primary Mental Abilities.

Educational implications and ideas for further research were also discussed.

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CHAPTER I

INTRODUCTION AND PROBLEM

> On one characteristic of the child's perception there seems to be general agreement: that he does not observe or only observes and remembers with difficulty, the orientations of shapes . . . (Vernon, 1957, p. 16).

The task of accurate letter discrimination and identification appears to be a major factor in the beginning stages of the reading process (Vernon, 1971). Wiener and Cromer (1967) state that, "identification presupposes a discrimination of one graphic symbol from others . . . (p. 635)". Thus they maintain that the ability to discriminate is a necessary antecedent if the child is to be able to identify and comprehend written language. Smith (1971), in a psycholinguistic analysis of reading, offers further support to the hierarchical process proposed by the foregoing authors. He suggests that the initial aspect involved in the task of letter identification requires ". . . the discrimination of various configurations as different, as not functionally equivalent (p. 115)."

The above authors, although they regard discrimination ability as a necessary requirement for success in reading, do not elaborate to any extent upon those features of alphabetic letters which they consider critical for accurate discrimination. Money (1966), however, offers a more extensive discussion of discrimination features in terms of spatial orientation. He postulates the law of directional constancy

which in effect states that alphabetic symbols and their serial arrangement within words must always be directionally oriented in the same manner. A glass, for example, retains its identity regardless of its spatial orientation. This, however, is not the case with many letters of the alphabet, such as b, p, d, and q.

Visual-spatial orientation ability, but with particular reference to a left-right gradient of discrimination in terms of one's body, has been researched and significant correlations to reading achievement have been found (Smith, 1970; Annand, 1971).

Further research (Popp, 1964; Blair and Ryckman, 1969), using lower case alphabetic letters, has shown that children between the ages of four and six have a tendency to confuse certain letters. However, the specific sources of confusion were not considered in any detail. Also the ability to discriminate these same letters and the relationship of this ability to reading achievement were not explored.

Smith (1928), however, in an earlier study did indicate that the ability to discriminate alphabetic letters was related to reading achievement. Therefore, although individual studies have examined letter discrimination and its relationship to reading achievement, no one study has examined difficulty with specific dimensions of letter discrimination and its relationship to reading achievement.

The ability to discriminate the directional or spatial orientation of alphabetic symbols is considered to be dependent upon the more basic ability of directional discrimination with reference to one's own body (Schilder, 1935; Piaget and Inhelder, 1967; Kephart, 1971).

Piaget (1953) outlines the development of an 'objective space' in which " . . . instead of bringing the universe to himself, the child begins to place himself in a universe which is independent of him (p. 212)". Both Piaget (1967) and Kephart (1971) propose rather similar developmental stages through which they maintain the child progresses in the development of spatial orientation. These stages range from the initial egocentric, sensori-motor stage to the conceptual or objective stage of spatial awareness.

Thus it appears that the ability to discriminate directionality with reference to one's own body precedes the ability to discriminate directionality in alphabetic letters. It would further appear that the foregoing discrimination abilities are related to success in the beginning stages of reading. However, such a hierarchical approach to reading achievement involving the examination of specific spatial dimensions both subjective (body referent) and objective (alphabetic letters) does not appear to have been attempted.

I. PURPOSE

The purpose then of this study is to examine a child's ability to discriminate letters which differ on a number of dimensions of directionality (left-right, vertical, combination of both) and the relationship of this ability to his level of reading achievement. It is further proposed to study the child's ability to discriminate the directionality of letters and its relation to his perception of directionality in terms of his own body.

II. DEFINITION OF TERMS

Directionality is a term used to denote a dimension in terms of a plane. The directions of concern in this study are left-right and vertical (for alphabetic symbols) as well as left-right, up-down and front-back (for body reference).

Discrimination of Directionality refers to the ability to distinguish directions or symbols which may be contrasted in terms of the dimensions left-right, up-down and front-back (body reference) and left-right and vertical (alphabetic symbols).

Body Directionality refers to the ability to discriminate, left-right, up-down and front-back directional dimensions with reference to one's own body and is measured in the present study by the Body Directionality Test.

Letter Directionality refers to the ability to distinguish between letters, in isolation, which differ on a left-right, vertical or combination of these dimensions and is measured in this study by the Letter Directionality Test.

Word Directionality denotes the ability to distinguish between letters, within words, which differ on a left-right, vertical or combination of these dimensions and is measured in this study by the Word Directionality Test.

Sentence Directionality is used in reference to the ability to distinguish between letters, within sentences, which differ on a left-right, vertical or combination of these dimensions and is measured in this study by the Sentence Directionality Test.

Subjective Directionality refers to the ability to distinguish directions (left-right, up-down, front-back) with reference to one's body. In this study it is used synonymously with Body Directionality.

Objective Directionality refers to the ability to distinguish directions (left-right, vertical) with reference to objects or symbols apart from one's body. In this study, objective directionality is measured by the Letter, Word, and Sentence Directionality tests.

Left-Right refers to a spatial dimension with reference to an individual's own body. A child's knowledge of this dimension is tested by asking him to perform tasks with reference to his/her own body, using the terms left-right. It also refers to the dimension by which two letters differ in terms of their orientation on a horizontal plane, e.g., b-d.

Vertical refers to the dimension by which two letters differ in terms of their orientation on a vertical plane, e.g., b-p.

Combination refers to the dimension formed by both vertical and left-right transformations taken together, and over which two letters differ in terms of their orientation, e.g., b-q.

Up-down refers to a spatial dimension with reference to an individual's own body. A child's knowledge of this dimension is tested by asking him to perform tasks with reference to his own body, using the terms above-below which for the purpose of this study are synonymous to up-down.

Front-back refers to a spatial dimension with reference to an individual's own body. A child's knowledge of this dimension is tested

by asking him to perform tasks with reference to his own body, using the terms in front of-behind, which for the purpose of this study are synonymous with front-back.

III. HYPOTHESES

Research Hypothesis 1

Grade one children's ability to discriminate directionality, both objectively and subjectively, is related to their level of reading achievement.

Null Hypothesis

There is no significant correlation between scores on the Neale Analysis of Reading Ability and:

(a) Scores on the Body Directionality Test
(b) Scores on the Letter Directionality Test
(c) Scores on the Word Directionality Test
(d) Scores on the Sentence Directionality Test

Research Hypothesis 2

Grade one children who are more successful in reading will be better able to discriminate the directionality of alphabetic letters.

Null Hypothesis

There is no significant difference between the scores obtained by high, average, and low reading achievers on:

(a) Letter Directionality Test
(b) Word Directionality Test
(c) Sentence Directionality Test

Research Hypothesis 3

The time taken by grade one children to complete a directional discrimination task will be related to the scores they obtain on that same task and also to their level of reading achievement.

Null Hypothesis

There is no significant correlation between times taken on the Letter, Word, and Sentence Directionality Tests and

(a) Scores on the Letter, Word, and Sentence Directionality tests
(b) Scores on the Neale Analysis of Reading Ability

Research Hypothesis 4

Grade one children who are more successful in reading will take less time to complete the directional discrimination tasks.

Null Hypothesis

There is no significant difference between the times taken by high, average, and low reading achievers to complete the:

(a) Letter Directionality Test
(b) Word Directionality Test
(c) Sentence Directionality Test

Research Hypothesis 5

Grade one children who differ in their level of reading achievement will make different types of directional discrimination errors.

Null Hypothesis

There is no significant difference between the types of errors made by high, average, and low reading achievers on the:

(a) Letter Directionality Test
(b) Word Directionality Test
(c) Sentence Directionality Test

Research Hypothesis 6

Grade one childrens' performance on directional discrimination tests involving alphabetic letters will be related to their performances on a test of general intelligence as well as a test of directional discrimination with reference to their own bodies.

Null Hypothesis 6

There is no significant correlation between scores on the Letter, Word, and Sentence Directionality tests and:

(a) I.Q. scores
(b) Body Directionality scores

The null hypotheses will be considered rejected when the probability of the results occurring by chance is .05 or less.

IV. ASSUMPTIONS

It is assumed that the children's performance is indicative of their actual ability to perform on the tests used in this study.

A second assumption is that the reading levels are reflective of the reading levels of grade one children within the Edmonton Catholic School System and are not randomly biased by any one of the schools used in the study.

V. LIMITATIONS

The following factors are recognized as limiting the

generalizability of the data collected in this study.

(1) The sample for the current study was selected from three urban schools within the city of Edmonton, Alberta. Rural students may exhibit somewhat different directional discrimination abilities due to differing environmental conditions.

(2) Children scoring more than one standard deviation below the mean I.Q. score were eliminated from the study. Generalizations, therefore, would not necessarily be applicable to children in this category.

(3) The children were tested after seven months in grade one. Consequently, generalizations would be restricted to grade one students who have spent a comparable amount of time in grade one.

(4) Ten letters of the alphabet lent themselves to rotations along the dimensions outlined for the purposes of this study. Thus, whereas generalizations may be readily made in terms of directionality dimensions, generalizability to specific letters is limited.

VI. SIGNIFICANCE OF THE STUDY

The role of discrimination, and in particular, directional discrimination, in the beginning stages of reading, has been discussed in the introduction of this chapter. Should the present study demonstrate a relationship between (a) Body Directionality, (b) Letter, Word, and Sentence Directionality, and (c) Reading Achievement, it would suggest that the ability to deal with spatial orientation firstly on a subjective level and secondly on an objective level, but particularly with alphabetic symbols, are essential factors to be considered in the beginning

stages of reading.

The present study may help to determine which method of examining letter directionality ability (i.e., letters in isolation, in words or in sentences) is more closely related to success in the beginning stages of reading. Such an instrument could then provide both an efficient and easily accessible method for identifying children experiencing difficulties in directional discrimination.

Present approaches to letter discrimination tend to approach the letter as an isolated whole. Hopefully, this study may provide the teacher with a more accurate method of identifying a child's difficulties in terms of directional discrimination on specific dimensions (i.e., left-right, vertical and a combination of the two). The resulting more specific diagnosis of difficulties would tend to facilitate attempts for remediation and enhance chances for success in mastering this specific ability.

If success in body directionality is found to precede the ability to discriminate the directionality of alphabetic letters, then any training program which seeks to train children in the discrimination of letters would need to consider body directionality as a basic component of such a program.

VII. OVERVIEW OF THE STUDY

In Chapter II the writer will review the available literature which is considered pertinent to the present study. In doing so, it is hoped to construct a framework in which to consider the present

research.

The experimental design of the study will be outlined in Chapter III. Information on the sample, as well as the construction and administration of the testing instruments, will be presented.

The results of the study will be analyzed and explained in Chapter IV.

The final chapter will present the summary, conclusion, implications and suggestions for further research.

CHAPTER II

REVIEW OF SELECTED RESEARCH

In order to read the child must be able to discriminate the directional orientation of alphabetic letters. There appears to be a developmental progression from gross discrimination of simple objects to the finer discrimination of letter-like forms and actual alphabetic letters. Some writers have also suggested that the ability to discriminate directionality in terms of one's own body precedes the above discrimination tasks.

The purpose of this chapter is twofold, namely: to consider the literature which has examined (a) the referent role played by the child's body in the development of spatial directionality and, (b) the perception of directionality in objective space and its possible relationships to reading achievement.

I. SPATIAL DIRECTIONALITY WITH A BODY REFERENT POINT

The literature which has examined the role the child's body plays in the development of directional awareness has been, to a great extent, theoretical in nature. Empirical studies which have explored the development of multi-dimensional directionality, i.e., left-right, up-down and in front of-behind, appear to be limited in number. Further, a majority of the research in this area has dealt with directionality solely on a left-right gradient. Also, only a limited number

of these studies have been concerned with directional discrimination and its relationship to reading achievement.

Kephart (1971) in recent years has been one of the leading proponents of the role of body image in the development of directional awareness. Directionality, he maintains, is a relative rather than an absolute concept. Thus it is necessary that a point of reference be established around which to coordinate objects in space. The body, he proposes, serves as this point of reference. The ability, therefore, to make directional discriminations of objects in space is founded upon the child's ability to discriminate these same directions with reference to his own body. Similarly, Piaget (1967), Schilder (1964) and Cratty (1970) have also described this same egocentric quality which they claim to be characteristic of the initial stages in the development of directional awareness. Thus, it is maintained that the ability to develop directional awareness is highly interrelated with body image.

Body image, according to Kephart (1971), ". . . is a learned concept resulting from the observation of movement of parts of the body and the relationship of the different parts of the body to each other and to external objects (p. 95)." Thus, the learning of directionality would appear to consist of a dynamic interaction involving the individual and the environment, a position which is also supported by Piaget and Inhelder (1967) as well as Siegal (1953).

Held and Hein (1963) studied ten pairs of kittens under two conditions of exposure: (a) stimulation varied as a result of the

kittens' own locomotion; (b) stimulation was varied by transporting the kittens through an equivalent range of motion while they were restrained from self-locomotion. Subsequent perceptual tests consisting of visually guided paw placement, discrimination on a visual cliff, and blink response indicated that the latter group scored significantly poorer than the former. The authors concluded that these results tend to substantiate the claim that visually guided behavior is not sufficient for the development of spatial orientation but rather that a dynamic interaction between the organism and the environment is necessary for the full development of spatial awareness.

In a review of Russian research in this area, Shemyakin (1961) stressed the learning aspect involved in the ability to differentiate the directions--forward-backward, left-right and upward-downward. A study by Voronova was cited as evidence. Voronova conducted experiments with children who had been stricken by poliomyelitis while of pre-school age, and who had consequently suffered chronic disturbances of the support-motor apparatus resulting in bed confinement. The ability to discriminate up-down directionality, which would appear to be more or less naturally developed due to gravitational forces, was found to be deficient in these subjects. Right-left directionality proved to be more easily discriminated than up-down. Voronova explained that ". . . while 'right-left' are the constant coordinates of the activities of a child even in a lying position, or a child who has not walked for some time, the 'up-down' vertical position is one to which many of the children are unaccustomed and have not

learned by experience (p. 212)."

As previously mentioned, considerably more studies have investigated the ability to discriminate directionality on a left-right gradient without considering the two remaining coordinates, namely front-back and up-down. Of these studies only three examined the development of left-right discrimination in normal children and its subsequent relationship to reading achievement. A further group of studies, of which only an overview will be presented here, examined the development of left-right discrimination in a clinical population.

Studies conducted by Harris (1957), Silver and Hagin (1960), Coleman and Deutsch (1964), and Belmont and Birch (1965) involved atypical sample populations. The variations of research design as well as the use of rather limited measurement instruments make conclusive statements impossible. However, these studies tended to indicate that children deficient in left-right directional discrimination also tended to be underachievers in school related tasks.

A study, however, which did establish a correlation between left-right discrimination and reading achievement was conducted by Cohen and Glass (1968). A positive relationship was evident in a grade one sample, but was not found with grade four children. The authors hypothesized on the basis of these results that left-right discrimination was a factor in the early stages of reading but was not directly related to success in reading at a later stage.

Smith (1970) investigated the relationship between left-right discrimination and reading achievement in a sample of sixty grade one

public school children. Left-right discrimination ability was determined by the Benton Test of Right Left Discrimination as well as a comparable non-verbal test. The Neale Analysis of Reading Ability was used to assess the level of reading achievement. Test results indicated that children who were able to discriminate left-right directionality with reference to their own bodies also scored higher on reading achievement, even after verbal ability was partialled out by covariance.

One of the subtests developed by Smith for his study required the subject to reproduce twelve nonsense words using magnetic letters on a metal tray. Whereas the scores of the subject's performance on this test were significantly correlated with reading achievement, an analysis of the error types and frequencies were not reported. Thus, it was not clearly established upon what gradient the errors were made or whether they involved the sequence of letters or the orientation of single letters.

A subsequent follow-up of Smith's (1970) work was conducted by Annand (1971) using the same children in their second year of school. Annand's findings tended to substantiate those of Smith in that those children who could discriminate left-right directionality with reference to their own bodies scored significantly higher in reading achievement than those unable to discriminate. However, when verbal or intellectual ability was covaried out this difference only approached significance ($p < .08$).

Annand (1971) further suggested that the directional

discrimination test used by both herself and Smith (1970) may have been more valuable as a diagnostic instrument if it had been timed.

II. DIRECTIONAL DISCRIMINATION IN OBJECTIVE SPACE

The ability to discriminate the directionality of objects in space, i.e., geometric figures, letters of the alphabet, is considered to be a more advanced developmental stage than the ability to indicate direction with reference to one's own body (Piaget, 1928). A certain amount of the experimentation in this area has been influenced by the work of Sutherland (cited by Fellows, 1966) in which he examined the directional discrimination ability of octopuses.

Directional Discrimination of Objects and Geometric Forms

Rudel and Teuber (1963) attempted to verify whether directionality difficulties observed in animal studies were essentially similar in the human child. The subjects used in their study ranged in age from three to eight years. The subjects were presented with cards displaying the discrimanda which consisted of vertical, horizontal (|,–), or oblique lines (/,\) as well as 'U' shaped figures (⊓ ⊔, ⊐ ⊏). Upon the initial presentation the children were shown that one figure was 'right' and the other was 'wrong' and as such they were expected to choose the 'right'figure on subsequent presentations.

Results showed that all the subjects, except six of the children from the younger age groups, were able to discriminate vertical-horizontal lines and the up-down 'U' figures. However, the oblique

lines, as well as the left-right presentation of 'U' figures proved considerably more difficult. Only seven children out of forty six in the younger group (3 years, 6 months - 5 years, 5 months) were able to reach criteria on fifty trials, while thirty-five out of forty-nine from the older group (6 years, 6 months - 8 years, 5 months) were able to achieve the criterion level. This study, then, tended to suggest a developmental influence in the learning of directionality as well as indicating that certain dimensions of directionality appeared to be more difficult (i.e., oblique and left-right) than others (horizontal-vertical and up-down).

Huttenlocker (1967), in a later replication of the above study, demonstrated that left-right discrimination tended to be, in general, more difficult than up-down.

Although the foregoing methods to test discrimination involve responding to the differences between the stimuli (Fellow, 1966, p. 1), it must be noted that they also involve a memory factor, in that the child was required to remember features of the stimulus in order to respond accurately to succeeding presentations.

A study which did eliminate this memory factor was conducted by Wohlwill and Wiener (1964). The sample involved children ranging in age between forty-seven and fifty-six months. The subjects were presented with a sample figure and two choice stimuli, one of which was identical to the sample, whereas the second was a left-right or up-down reversal of the sample. Also four of the eight figures were ranked as highly directional while the other half were classified as

low in directionality.

Test scores indicated that the children were able to discriminate the orientation of the test stimuli with a consistently high degree of accuracy (i.e., mean error of 5.4 on thirty-two trials). However, differences between errors on a left-right dimension and an up-down dimension did prove significant with the mean number of errors on the former gradient proving to be greater. On the basis of these results Wohlwill and Wiener proposed that children of a preschool age are capable of a high level of directional discrimination. They suggested that difficulties experienced with letters resulted due to difficulties experienced in learning a new set of responses (i.e., letter names) to stimuli (i.e., letters) which differ on the basis of directionality (i.e., b-d; p-q).

The sample of subjects involved in the above study came from predominantly upper-middle class homes. Further, prior to the final testing, the experimenters ran a pre-training series which resulted in two subjects being eliminated for not reaching criteria. However, nineteen of the twenty-four subjects made errorless pre-training criterion attempts. Also, since no attempt was made to control for an intelligence factor it would appear that this study involved possibly a somewhat select sample which apparently reached the ceiling of the given test quite readily. Finally, the authors tended to make generalizations concerning directionality discrimination when in fact they had examined only two directions, namely, left-right and up-down but had omitted front-back.

A study which examined directionality on all three spatial axes, unlike the two dimensional study by Wohlwill and Wiener (1964), was conducted by Wechsler and Hagin (1964). The sample of children consisted of fifty first grade one children (5 years, 11 months - 6 years, 11 months) and fifty grade three children (7 years, 11 months - 9 years, 11 months). The directionality test consisted of an asymetric figure roughly shaped like lamb chop and which was rotated on a horizontal, vertical and depth axis. On the first series the subject was asked to match a stimulus figure with one of the six simultaneously presented response figures. On a second series the stimulus figure was exposed for three seconds and then removed. Following this the subject was asked to select the appropriate response figure. Reading scores for the first grade group were obtained using the Metropolitan Readiness Test as well as teacher's ratings. Scores on the California Reading Test were used for the third grade sample.

The differences between the mean number of correct responses on the directionality test for the groups of good and poor readers proved to be significant. These results were obtained for both the grade one and three samples using the total scores obtained from the matching and recall series ($t = 3.65$, $< .01$ and $t = 3.02$, $< .01$ respectively). An analysis of the percentage of errors for both good and poor readers showed significant differences for the grade one sample over left-right, front-back and up-down rotations ($p \leq .01$) on the matching series. However, for the grade three group only the percentage of up-down errors proved to be significantly different between the reading

groups on the matching series ($p < .01$). On the basis of these results Weschler and Hagin (1964) concluded that the accurate perception of spatial directionality does, in fact, play a role in reading progress. Unfortunately, in this study, however, the authors gave indication that intelligence, as a possible intervening variable, was controlled for.

The foregoing studies, then, tend to suggest the involvement of a developmental as well as a learning factor in directional discrimination ability. Also a relationship between this ability and reading achievement appears to be indicated by the work of Weschler and Hagin (1964). However, these studies do not clearly establish how this ability relates to the discrimination of alphabetic letters.

Directional Discrimination of Letter-Like Forms

An experiment which more closely approximated the use of alphabetic letters was conducted by Gibson et al (1962). The authors examined the development of the ability to discriminate letter-like forms in children aged four through eight years in grades ranging from kindergarten to three. The discrimination task consisted of matching a standard letter-like form with an identical form. The form to be chosen was placed in a row with twelve specific transformations. In addition to examining rotation and reversal errors, Gibson also examined line to curve and break and close transformations. Rotation and reversal transformations will be considered in this review.

The number of rotation and reversal errors started quite high

for four year olds (6.56 and 6.47 on twelve trials each for both right-left and up-down dimensions respectively) and decreased considerably for eight-year-olds (0.59 and 1.08 for left-right and up-down respectively). Further, correlations using the same procedure and capital letters were quite high for these same dimensions, namely, .77 and .75.

Gibson et al (1962) reasoned that in order for a child to be able to discriminate between the various transformations he must attend to the distinctive features of the form. Therefore on the basis of the rather rapid decrease in rotation and reversal errors made by subjects from four to eight years it was further suggested that the child, during this period, learns that these types of directional transformations are significant for distinguishing graphic forms. A subsequent study by Williams (1969) tended to substantiate the basic findings of Gibson et al. Williams further demonstrated that training in the discrimination of these forms proved to be of significant value in increasing the discrimination ability of kindergarten children.

Although Gibson et al (1962) did establish rather high correlations between discrimination scores obtained using letter-like figures and actual capital letters, it must however, be noted that for the average beginning reader the letters he most frequently encounters are lower case letters. Therefore for the purposes of reading it would appear more appropriate to examine those symbols encountered in the reading process, namely, alphabetic letters and, in particular, lower case letters.

Directional Discrimination of Letters

Popp (1964), using Gibson's (1962) basic hypothesis of distinctive features, provided further insight into the discrimination of lower case alphabet letters. The sample consisted of kindergarten children ranging in age from five years, one month to six years, one month. The testing apparatus was a rear projection projector which advanced slides upon the selection of a correct response by the child. The sample letter stimulus was presented in a central position while the two choice stimuli were presented below and to the left and right. The results tended to substantiate the author's hypothesis that most confusion errors arise as a result of reversals and rotations (p-q; b-p; n-u). It was shown that certain letter pairs appeared to be more susceptible to confusion (i.e., p-q, 10 errors; b-d, 9 errors; b-q and d-p, 7 errors) than others.

A subsequent experiment conducted by Blair and Ryckman (1969) followed essentially the same method as Popp (1964) with the exception that cards rather than a projector were used. Test results basically tended to substantiate the findings of Popp, namely, certain pairs of letters appeared to cause greater discrimination confusion.

In both of the foregoing studies the relative positioning of the sample item and choice stimuli raise a methodological problem. Research has shown that the relative position of stimuli in a discrimination task proved to be a highly influential factor (Huttenlocker, 1967; Cairns and Steward, 1970). In the studies conducted by Blair and Ryckman (1969) and Popp (1964), the sample item and the choice stimuli were

arranged on a vertical dimension, thus possibly biasing the type of errors made. Further, it should also be noted that, with reference to reading, the normal positioning of letters is on a horizontal or left-right plane.

Smith (1928), in a much earlier experiment had demonstrated that certain letters of the alphabet, both upper and lower case, tended to result in more confusion errors. However, unlike the foregoing studies, Smith also examined the relationship of letter matching ability and reading achievement. Using a sample of grade one children, a rather high correlation coefficient of .87 was established.

Although the children selected for Smith's study were chosen from three different intelligence groups (i.e., superior, average, below average), intelligence as a factor was not covaried out from the correlation. Thus, such a high correlation coefficient remains somewhat dubious.

Summary

In summary, therefore, the reviewed literature tends to suggest that the ability to discriminate directionality using the body as a referent point is both a learned and a developmental process. This ability to deal with subjective directionality also appears to be a prerequisite for the development of directional awareness in objective space.

It was further implied that reading achievement, in particular, may be related to a child's ability to discriminate directionality on a left-right gradient with reference to his own body. However, although

the learning as well as developmental nature of this correlation is implied by a number of the reviewed theoretical and empirical papers, it is not clearly dealt with in those papers concerned with reading research.

The majority of the research which has examined the child's ability to deal with directional orientation in objective space has predominately utilized geometric figures. However, these studies also appear to indicate the involvement of a learning and developmental process. It would further seem that certain directionalities present greater difficulties than others.

Comparable research pertaining to alphabetic letters, however, tends to have examined discrimination ability more in terms of distinctive features rather than specific directional dimensions. Of these studies only one sought to establish the relationship of this directional discrimination ability and reading achievement.

In conclusion, therefore, it appears that individual studies have, to varying extents, examined the developmental and learning aspects of both subjective and objective spatial directionality over three gradients (i.e., left-right; up-down; front-back). However, there does not appear to have been any attempt to integrate these aspects of directional ability and explore the nature of their relationship to letter discrimination and reading achievement. In the following chapter, the design for such a study will be described.

CHAPTER III

THE EXPERIMENTAL DESIGN

This chapter describes the design, sample selection, test instruments as well as their reliability and validity, pilot study, method of data collection, and finally, the statistical measures used.

I. DESIGN OF THE STUDY

The main purpose of this study was to investigate the ability to discriminate directionality over three dimensions (i.e., left-right, up-down, front-back) and its relationship to the beginning stages of reading achievement. The children's ability to discriminate directionality in both subjective (body referent) and objective (alphabet letters) space was assessed. The body dimensions involved left-right, up-down, and front-back, while the letters were transformed over left-right, vertical, and a combination of these two dimensions. A sample of grade one readers, of at least average IQ, was chosen with equal distributions over sex, and over high, average and low reading ability. This, therefore, involved groups of thirty boys and girls with twenty of each high, average and low achieving readers.

Analysis of variance and correlations were the main procedures used in analyzing the obtained data.

II. SAMPLE SELECTION

The sample for this study was chosen from the grade one classes

of three schools within the Edmonton Catholic School System. The children were distributed over five different classrooms. A grade one sample was selected because this is the first year of formal reading instruction, and it is at this level that the greatest influences of directional discrimination ability on their reading achievement are expected.

Since it was thought that visual difficulties might influence the performance on the Letter, Word and Sentence Directionality tests the total population of ninety-seven children were administered a visual screening test. The Keystone Telebinocular was used to assess each child's visual efficiency. The children were tested on three of the Keystone Visual Survey Tests - lateral posture, fusion and usable vision with both eyes, all at near point. These three basic areas were considered to be essential for unhampered visual functioning while reading. Further, near point was used because all the testing involving vision was performed at near point. On the basis of this test ten children were eliminated from the sample and referred for further visual testing.

It was also felt that below average I.Q. may be an important factor in test performance. Consequently, the SRA Primary Mental Abilities K-1 was administered to the total grade one population, and two children, whose scores fell more than one standard deviation below the mean, were eliminated from the sample.

Also eliminated from the study were three children who were absent for the administration of the intelligence tests.

The remaining eighty-three children were divided into groups of high, average and low readers on the basis of their reading accuracy performance on The Neale Analysis of Reading Ability (Form A, 1966). A stratified random sampling procedure was then followed and sixty children were chosen with equal distribution over reading ability and sex. One child who was subsequently eliminated from the sample due to absenteeism was replaced by a randomly selected substitute.

The final sample, therefore, consisted of thirty boys and thirty girls with a mean age of 81.07 months (6 years, 9.07 months) and a standard deviation of 3.45 months. Table 1 summarizes the chronological ages, I.Q.s and reading accuracy scores of the sample.

III. TEST INSTRUMENTS

Standardized Tests

(1) The Keystone Visual Survey Test

This visual screening device is produced by the Keystone View Company of Meadville, Pennsylvania, U.S.A. It is an individually administered test which involves the use of the Keystone Telebinocular instrument. This instrument requires the child to look through two glass lenses and respond to the examiner's questions concerning the visually presented stimuli. The total test consists of fourteen card presentations or subtests, nine of which are placed at the far-point position, which is the equivalent of an actual distance of twenty feet. The remaining five card presentations are placed at the near-point

TABLE 1

MEAN CHRONOLOGICAL AGE, READING ACCURACY AND INTELLIGENCE QUOTIENT SCORES OF THE SAMPLE

	Boys			Girls			Total		
Reading Achievement Groups	Chronological Age	Reading Accuracy	Intelligence Quotient	Chronological Age	Reading Accuracy	Intelligence Quotient	Chronological Age	Reading Accuracy	Intelligence Quotient
High	$\bar{X}$ 80.60	26.90	115.09	80.20	30.30	116.10	80.40	28.60	115.60
	SD 3.30	4.68	9.28	4.26	11.48	8.57	3.78	8.71	8.71
Average	$\bar{X}$ 82.70	19.40	114.00	79.70	16.70	107.70	81.20	18.05	110.85
	SD 2.26	2.41	6.13	3.89	2.16	5.80	3.07	2.63	6.64
Low	$\bar{X}$ 81.70	8.20	103.30	81.50	9.40	105.80	81.60	8.80	104.55
	SD 3.62	3.74	9.12	3.06	2.50	8.74	3.34	3.16	8.79
Total	$\bar{X}$ 81.06	18.17	110.80	80.46	18.80	109.87	81.07	18.48	110.33
	SD 3.06	8.60	9.67	3.73	11.04	8.81	3.46	9.82	9.18

which is the equivalent of an actual distance of sixteen inches.

As suggested in the Keystone Instruction Manual (1961) a child experiencing difficulties in lateral posture, fusion and usable vision at near-point would also be hampered in reading at near-point. Therefore, considering the nature of the instruments involved in the present study, the foregoing subtests were used to screen out children experiencing visual deficiencies in these areas.

(2) SRA Primary Mental Abilities - K-1 (revised 1963)

This instrument was designed to provide both multifactored and general measures of intelligence. At the K-1 level, there are four subtests, each of which measures a primary ability, while the total score provides an estimate of general intelligence. The four primary abilities assessed by the subtests are:

Subtest 1 - Verbal Meaning: The child is required to demonstrate an understanding of orally expressed ideas by marking one of four possible pictures. There are forty-nine test items as well as seven practice items.

Subtest 2 - Number Facility: This is comprised of simple quantitative problems requiring the child to count, add and subtract. The child is asked to respond by marking the appropriate number of pictures. There are twenty-seven test items and seven practice items.

Subtest 3 - Perceptual Speed: The child's ability to see likenesses and differences between objects and symbols (pictures and silhouettes) quickly and accurately is measured. This is a matching

to model task consisting of twenty-eight test items and seven practice items. There is a time limit for this test.

Subtest 4 - Spatial Relations: This subtest measures a child's ability to visualize objects and figures rotated in space and the relations between them. The first task requires the child to mark the choice figure which completes the sample stimulus. The second task involves completing a geometric figure from a given model. Altogether there are twenty-four test items and ten practice items.

Reviews (Buros, 1972) have indicated test-retest reliability coefficients ranging between .83 and .95. Validity was established by correlating test scores with the results obtained on the SRA Achievement Series: Reading. The test authors, although they did not provide correlation coefficients, maintained that correlations were satisfactory.

(3) The Neale Analysis of Reading Ability (Form A, 1966)

This test was chosen as the measure of reading achievement mainly because it is both easily administered and well-standardized. This oral reading test allows for a measurement of reading accuracy and comprehension ability. Allowance is also made for reading rate. However, this measure was not included as it was not considered pertinent to this study.

The test, which is administered individually, consists of six passages of graded difficulty and increasing length, with controlled variation of vocabulary and sentences. Reliability coefficients for accuracy scores on alternate forms exceed .96. A validity coefficient of .95 was obtained using the pooling square method over the following tests:

Ballard One-Minute Test, Vernon Word Reading Test, Holburn Scale, Peel English Test and the Schonell English Usage Test (Neale,1965).

IV. TESTS CONSTRUCTED FOR THIS STUDY

A review of the related literature indicated that no test was available which measured an individual's ability to discriminate left-right, up-down and front-back directionality using a body referent point. Also not available were tests which measured discrimination of letters over three dimensions (i.e., left-right, vertical and a combination of these two dimensions). Therefore, four tests were constructed in order to assess these directional discrimination abilities. Body Directionality was designed to assess body referent directional ability--left-right, up-down and front-back. Letter Directionality, Word Directionality and Sentence Directionality were constructed to assess an individual's ability to discriminate the directionality of letters--left-right, vertical, and a combination of these two dimensions.

The construction of such tests, however, also required the establishment of validity and reliability. Pertinent data will be reported in a subsequent section of this chapter.

Body Directionality Test

The Body Directionality Test is an experimental test constructed by the writer and designed to measure the extent to which a subject had attained the ability to discriminate left-right, up-down and front-back directions with reference to his own body. Thus, the subject was

required to respond to an oral directive by indicating a particular direction using his own body as a referent point.

Because of the symmetrical nature of the human body, on a left-right dimension (i.e., left ear-right ear, left hand-right hand), it was considered sufficient for an individual to indicate a particular lateral body part (i.e., show your left leg) in order to demonstrate directional proficiency on this dimension. Those items which required left-right discrimination were based upon Benton's (1959) Form A of Right-Left Discrimination Battery (p. 14).

Unlike left-right directional discriminations the remaining two dimensions--up-down and in front of-behind were not as easily demonstrated or observed with reference to the body. Therefore, in order to lend greater clarity to the subject's response, he/she was asked to hold a small wooden cube (3/4") in a specified location (i.e., Put the block below your chin). In this manner the experimenter could more accurately observe the spatial direction indicated by the subject. The Purdue Perceptual Motor Survey (Roach and Kephart, 1966), sub-test Identification of Body Parts (p. 34), was used to develop an appropriate sample of test items.

The spatial terms, right-left, in front of-behind, above-below, were shown by Mannall-Fretwell (1971) to be readily understood by grade one children.

The total test consisted of thirty items equally distributed over three directional gradients (i.e., left-right, in front of-behind, up-down). The first half of the test, containing an equal distribution

of directional items, was performed with the subject's eyes opened, the second half was performed with the subject's eyes closed. A single point was given for each correct response. A copy of the test may be found in Appendix A.

Letter Directionality Test

The Letter Directionality Test* was constructed by the writer in order to measure the subject's ability to discriminate between isolated alphabetic letters varied over three spatial dimensions. Lower case letters were chosen since they are the letters most commonly encountered in a reading situation. The ten letters actually used in this test were selected on two criteria. Firstly, the letter had to be asymmetrical in order that it could be drawn in different spatial orientations without becoming an actual match of itself (i.e., b-d vs. v-v). Ten letters were eliminated because they were symmetrical. Secondly, of the sixteen remaining letters, ten were chosen that either matched another letter when spatially transformed (n-u) or closely approximated another letter (h-y) as a result of spatial transformation.

The selected letters were transformed over three dimensions--left-right (b-d), vertical (b-p), and a dimension which is described as a combination of the two former (b-q) dimensions. The test was constructed to elicit a matching to sample response. The choice stimuli consisted of the sample stimulus transformed over the three specified dimensions, the sample itself and also a distractor letter. The sample

*See Appendix A for a complete copy of the test

stimulus was placed on the left side of the page and choice stimuli were then randomly placed to the right on the same horizontal plane. This positioning of the letters on a horizontal plane is thus similar to the spatial positioning of letters in a normal reading situation.

The subject was given two practice attempts using two letters not used in the letter sample. When errors were made on these practice items the subject was redirected until the error was corrected. Each sample letter in the test was presented twice, thus giving twenty items which were randomly ordered. The subject was required to draw a line through the choice stimulus which matched the sample stimulus a single point was given for each correct choice. As suggested by Annand (1971) a time score was also obtained for this test.

Word Directionality

The Word Directionality Test* was constructed by the writer in order to assess the subject's ability to discriminate between alphabetic letters, varied over three spatial dimensions and placed within the context of nonsense words. The ten sample letters used in the Letter Directionality Test were also used in this test. The purpose for using words in this particular test was in order to more closely approximate the reading situation encountered by the child, namely, the discrimination of letters within words.

Ten three-letter nonsense words and ten five-letter nonsense words were used in the test. In the three-letter words a medial

*see Appendix A for a complete copy of the test.

vowel (e) was held constant (ved), while the vowels (i.e., e, a) in the five-letter words were held constant at the second and third position (fedal). Using a stratified random procedure, five of the stimulus letters were placed in an initial position and the remaining five in the final position in the three-letter words. For the five-letter words, those letters which were in the initial position of the three-letter words were randomly placed in either the medial or final position. Similarly, those letters which had been in a final position were randomly placed in either a medial or initial position.

The format of this test was similar to that of the Letter Directionality Test. That is, the stimulus word and choices were placed on a horizontal line and the subject was asked to choose the word which was the same as the first word (as the left-hand side of the page). One point was given for each item correctly marked. A time score was also obtained for this test.

Sentence Directionality Test

The Sentence Directionality Test* was constructed to measure the subject's ability to discriminate between alphabetic letters varied over three spatial dimensions and placed in real words within the context of a sentence. The sample letters used in the Letter Directionality Test and Word Directionality Test were also used in this test. The purpose for placing the letters within the context of a sentence was in order to further approximate the situation in which the

*See Appendix A for a complete copy of the test.

child generally encounters letters while reading, namely, in sentences.

The sample letters were randomly placed in words which were subsequently placed within sentences. The average sentence was approximately four words in length. The format of this test and the scoring procedure were similar to that used for the two previous tests. A time score was also obtained for this test.

Validity

A testing instrument may be said to be valid if it measures what it is intended to measure. There are different kinds of validity. Content validity refers to the degree to which an instrument samples a given situation or variable. For the present newly constructed tests, this type of validity (i.e., content) will be discussed.

The purpose of the Body Directionality Test was to measure the subject's ability to discriminate directionality over three dimensions - left-right, above-below, in front of-behind, with reference to his/her own body. It was further considered that the subject's response to the oral directive was indicative of his/her spatial directional ability.

The oral directions consisted of the words - 'left-right, in front of-behind, above-below', which actually describe the dimensions to be discriminated. Further, those items which required left-right discrimination were based upon Benton's (1959) Form A of Right Left Discrimination Battery (p. 14). The Purdue Perceptual-Motor Survey (Roach and Kephart, 1966) subtest, Identification of Body Parts (p. 34) served as a model in developing the remaining test items.

The focal point of the Letter, Word, and Sentence Directionality

Tests was the orientation of particular letters. Letters were chosen which were asymmetrical and which, when oriented in different directions, could be confused with another letter form.

The Letter Test formed the basis of the other two tests. Thus, the Letter Test was constructed first and submitted to three adults who were asked to indicate the orientations (left-right, vertical, combination) of the various choices. All orientations were identified with perfect agreement.

The stimulus letters and the possible choices were then randomly placed in words and sentences. In addition to the position of each single choice within an item, the order of the items themselves was also randomized.

Thus, given the purposes of these tests - Body, Letter, Word, and Sentence Directionality, as well as the nature of the task required by the test, it is felt, therefore, that these instruments actually measure what they propose to measure. Subsequently, it is considered that these devices fulfill the requirements of content validity.

Reliability

A split-half method of achieving a measure of reliability was used for the present tests. This procedure provides an estimate of the internal consistency or homogeneity of the instrument, thereby indicating the extent to which the items of the test are measuring the same thing. In order to achieve this, the items of the tests were divided on the basis of being even or odd-numbered, and the scores obtained on both halves were correlated. Dividing the test, however,

shortens it considerably, and also tends to reduce its reliability. Thus, a Spearman-Brown formula was applied in order to correct for this reduction of length. The reliability data for the Directionality Tests are reported in Table 2. The reliability coefficients for the Body Directionality Test and the Sentence Directionality Test were .93 and .90 respectively, and were felt to be quite adequate.

TABLE 2

RELIABILITY COEFFICIENTS FOR TESTS CONSTRUCTED FOR THIS STUDY

Tests	Body Directionality	Letter Directionality	Word Directionality	Sentence Directionality
Reliability Coefficients*	.93	.66	.41	.90

*Corrected using the Spearman-Brown formula.

The obtained reliability coefficients for the Letter and Word Directionality Tests did not indicate the actual consistency which existed between the even and odd scores. Due to the fact that the scores clustered at or near the ceiling level (ninety-two and seventy-three per cent of the even-odd scores were either nine or ten respectively), the resulting correlation coefficient tended to decrease. An examination of the even-odd scores on a bivariate frequency distribution indicates a high degree of agreement between even-odd scores. Thus, for the Letter Directionality Test eighty-five per cent of the even-odd scores lay within one point of each other, while for the Word Directionality Test the figure was seventy-three per cent. Therefore, it may

be concluded that for both of these tests there exists a consistency of agreement between even and odd scores using a split-half test of reliability.

V. PILOT STUDY

A pilot study, using nine grade one children, divided equally into high, average, and low reading groups on the basis of their teachers' ratings, was conducted approximately one month prior to the final data collection. The purpose of the pilot study was to obtain further information with regard to the following areas: (a) to determine whether the Letter, Word, and Sentence Directionality Tests should be administered individually or in groups; (b) to test whether there was evidence of differing performances by the high, average and low readers; (c) to check out the test instructions used, as well as the possible effects of varying the sequence of test administration; (d) to assess the amount of time necessary to complete the tests.

On the basis of the results of the pilot study, the following decisions were made. (a) A group of four children was considered adequate for the administration of the Letter, Word, and Sentence Directionality Tests. (b) There appeared to be differences between the children on their performances in the Directionality Tests. However, in order to increase the instruments' reliability the number of items was doubled. (c) The children appeared to comprehend the instructions without difficulty. The sequence of test administration did not seem to influence the children's performance on any of the tests. (d) The

total time involved in the administration of the three, Letter, Word, and Sentence Directionality Tests, was approximately twenty minutes, which did not appear to cause the children any undue strain.

VI. COLLECTION OF DATA

All the visual screening tests were individually administered by the experimenter to each subject. This screening process lasted approximately three to five minutes per child. The Neale Analysis of Reading Ability was also individually administered. However, a fellow researcher working in a related study administered approximately half of the tests, while the remainder were administered by the experimenter. Approximately five to fifteen minutes were involved in this testing, depending upon the number of passages read.

The Body Directionality, which was administered to each subject individually by the experimenter, generally lasted three to four minutes. The Letter Directionality, Word Directionality, and Sentence Directionality were all administered in the above order at one testing session to a group of four subjects. The total mean time involved for these three tests together was approximately twenty minutes per group.

All of the foregoing tests were administered during class time. Private rooms were made available for each testing session.

The SRA Primary Abilities Test was administered to each grade one class as a total group within their respective classrooms. The test authors recommend one proctor per ten children being tested in groups. Therefore, the classroom teacher, a fellow researcher, and

the writer were involved in the administration of the I.Q. test. The testing was conducted during class times at two different sessions with rest intervals allotted for during each session.

VII. ANALYSIS OF DATA

The data for this study were analyzed, using the following analysis:

(1) Pearson Product Moment Correlation (DEST 02)

Using this test correlation matrices were computed for directionality, reading and I.Q. variables over reading groups, sex and the total sample.

(2) Partial Correlation (APL STP2)

The effect of the I.Q. variable was partialled out from reading and directionality correlations using this APL function.

(3) One Way Analysis of Variance (ANOV 15)

This one-way analysis of variance was used to determine whether differences existed between the reading groups on time and directionality scores as well as the types of directionality errors made.

(4) Scheffe Multiple Comparison of Means (ANOV 15)

This procedure was used as a comparison of means following the above analysis of variance. In this manner it could be determined whether there were significant differences between the means.

(5) Test of Significance of Difference Between Proportions (Ferguson 1966)

This test was used to examine the proportional differences between the types of errors made by each group on a particular directionality test.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

The purpose of this chapter is to present and discuss the analysis of the test results under the following headings:

(1) Directional Discrimination Ability and Reading Achievement

(2) Time as a Factor in Directional Discrimination Ability

(3) Analysis of Directional Error Types

(4) Discrimination and Related Variables

I. DIRECTIONAL DISCRIMINATION ABILITY AND READING ACHIEVEMENT

The subjects were divided according to their reading achievement level into high, average and low readers. Table 3 outlines the mean scores and standard deviations for each of these groups on the Directionality tests. The results indicate that the high reading achievement group attained the highest scores on all of the directionality tests, followed by the average and low reading group respectively. In general the greatest differences appeared to exist between the low and high group, (i.e., Sentence test - Low - 10.70, High - 15.95) as well as between the average and low group (Sentence test - Low - 10.70, Average - 14.75). However, the average and high groups did not display the same degree of differences in their scores.

Results on the Body Directionality Test tended to approach the ceiling level with the low group having a mean score of eighty per cent

TABLE 3

MEANS AND STANDARD DEVIATIONS OF DIRECTIONALITY TESTS OVER HIGH, AVERAGE AND LOW READING GROUPS

READING ABILITY LEVEL		Directionality Tests									
			Body Total=30		Letters Total=20		Words Total=20		Sentences Total=20		Total Total=60
	High	$\bar{X}$	28.45	$\bar{X}$	19.29	$\bar{X}$	17.34	$\bar{X}$	15.95	$\bar{X}$	52.54
		S.D.	2.50	S.D.	1.41	S.D.	1.89	S.D.	2.63	S.D.	5.24
	Average	$\bar{X}$	25.00	$\bar{X}$	19.25	$\bar{X}$	17.05	$\bar{X}$	14.75	$\bar{X}$	50.45
		S.D.	4.21	S.D.	.80	S.D.	2.28	S.D.	2.77	S.D.	4.41
	Low	$\bar{X}$	24.75	$\bar{X}$	18.00	$\bar{X}$	16.35	$\bar{X}$	10.70	$\bar{X}$	45.05
		S.D.	3.89	S.D.	2.05	S.D.	2.06	S.D.	3.48	S.D.	6.08

of the possible total. These results appear to suggest that the subjects had developed a generally high level of directional discrimination using a body referent point. This same tendency toward ceiling level is apparent in the Letter Directionality Test (High - 19.29, Average - 19.25, Low - 18.00) and to a lesser extent in the Word Directionality Test (High - 17.34, Average - 17.05, Low - 16.35). The Sentence Directionality means, however, do not seem to reach the same high levels (High - 15.95, Average - 14.75, Low - 10.70). Thus, there appears to have been established a hierarchical pattern of directional discrimination. The ability to deal with a body referent direction and the direction of an isolated letter seems to have been well mastered. However, the directional discrimination of a letter within the context of a word seems to have presented more difficulty while the ability to deal with the directional orientation of a letter within the context of a sentence appears to have caused the greatest amount of difficulty.

As Table 4 indicates, all the directionality tests, with the exception of Word Directionality, reached a level of significance ($p<.01$) in their correlation with reading accuracy scores. Low correlations were established between Letter as well as Word Directionality and reading comprehension. Significant correlations, however, were found between Sentence, Body Directionality and reading comprehension ($p<.01$) and also between the Total directionality scores and reading comprehension ($p<.05$).

TABLE 4

CORRELATIONS BETWEEN DIRECTIONALITY TESTS AND READING ACHIEVEMENT

		DIRECTIONALITY TESTS				
		Letter	Word	Sentence	Total	Body
Reading Achievement Measure	Reading Accuracy	.33**	.13	.56**	.48**	.33**
	Reading Comprehension	.17	.02	.39**	.25*	.34**

** Significant at the .01 level

* Significant at the .05 level

When the I.Q. factor was subsequently partialled out from the foregoing correlations (Table 5), only the Sentence Directionality Test maintained a significant level of correlation with both reading accuracy ($p<.01$) and reading comprehension ($p<.05$). Statistically significant levels were also maintained between the Total Directionality scores and reading accuracy ($p<.05$), as well as Body Directionality and reading comprehension.

The Sentence Directionality Test appears to have maintained the highest and most consistent correlation to reading achievement. The apparent correlation between the Total Directionality scores and reading accuracy may possibly be accounted for by the rather strong

TABLE 5

CORRELATIONS BETWEEN DIRECTIONALITY TESTS AND READING ACHIEVEMENT WITH I.Q. PARTIALLED OUT

		DIRECTIONALITY TESTS				
		Letter	Word	Sentence	Total	Body
Reading Achievement Measure	Reading Accuracy	.12	.04	.42**	.31*	.19
	Reading Comprehension	-	-	.27*	.09	.25*

** Significant at the .01 level

* Significant at the .05 level

influence of the Sentence Directionality Test ($r=42$, $p<.01$) with a minimum of influence from the Letter (.12) and Word (.04) Directionality tests. It appears noteworthy that the Sentence Directionality Test was the only directionality score to maintain a significant positive correlation with reading accuracy after the intelligence factor had been covaried out. A possible explanation of this phenomenon may be that the Sentence Directionality Test involves a learning factor more similar to acquiring success in reading and, to a more extensive degree, for children at this level, than is involved in the remaining directionality measurements.

An analysis of the correlations between directionality and

reading achievement for the three reading groups (Table 6) indicated no significant correlations between directionality scores and reading measures over the three achievement levels. With the exception of the average reading group, the highest correlations with reading accuracy scores were found with sentences, a trend somewhat similar to that established using the total sample.

An analysis of the correlations by sex showed that the correlations between the Word Directionality Test results and reading achievement scores distributed over sex (Table 7) proved to be rather low and non-significant in a pattern equivalent to that already discussed in the foregoing groupings. The Sentence Directionality Test proved to be significantly correlated with reading accuracy ($p<.01$) and reading comprehension ($p<.05$) for both boys and girls. A similar pattern of correlations is also evident for the Letter, Word, Sentence Total score with the exception of the correlation between reading comprehension results for boys which only approaches significance ($p<.18$). Letter Directionality scores were significantly correlated with reading accuracy results ($p<.05$) for both boys and girls, but not with reading comprehension scores. The girls seemed to demonstrate much higher correlations between reading scores and Body Directionality ($r=.37$, $.42$, $p<.05$) than the boys, who maintained the same non-significant correlation ($r=.27$) with the reading achievement measures.

As a result of partialling out the I.Q. factor, a pattern quite similar to that involving the total group under the same covariant conditions tended to emerge (Table 8). The results of the Sentence

TABLE 6

CORRELATIONS BETWEEN DIRECTIONALITY TESTS AND READING ACHIEVEMENT OVER HIGH, AVERAGE AND LOW READING GROUPS

			Directionality Tests			
		Letter	Word	Sentence	Total	Body
READING ACHIEVEMENT LEVELS	Reading Accuracy	High	.14	-.10	.24	.12	.06
		Average	.14	-.31	.06	.01	-.02
		Low	-.26	.26	.39	.37	-.03
	Reading Comprehension	High	-.22	-.36	-.13	-.25	.20
		Average	.16	-.01	.10	-.09	.22
		Low	.07	.21	.42	.36	.21

TABLE 7

CORRELATIONS BETWEEN DIRECTIONALITY TESTS
AND READING ACHIEVEMENT OVER SEX

			Directionality Tests				
			Letter	Word	Sentence	Total	Body
READING ACHIEVEMENT MEASURE	Reading Accuracy	Boys	.36*	.12	.62**	.52**	.27
		Girls	.38*	.13	.52**	.48**	.37*
	Reading Comprehension	Boys	.20	.06	.40*	.25	.27
		Girls	.24	.04	.43*	.35*	.42*

*Significant at the .05 level

**Significant at the .01 level

Directionality Test tended to display the most consistent significant level of correlation with reading achievement. Both boys' ($p < .01$) and girls' ($p < .05$) reading accuracy scores correlated significantly with Sentence Directionality results. However, only the correlation between the girls' reading comprehension and Sentence Directionality attained a level of significance.

TABLE 8

CORRELATIONS BETWEEN DIRECTIONALITY TESTS AND READING ACHIEVEMENT OVER SEX WITH I.Q. PARTIALLED OUT

			DIRECTIONALITY TESTS			
			Letter	Sentence	Total	Body
Reading Achievement Measure	Reading Accuracy	Boys	.08	.47**	.30	-
		Girls	.26	.39*	.35*	.28
	Reading Comprehension	Boys	-	.23	-	-
		Girls	-	.38*	.28	.38*

** Significant at the .01 level

* Significant at the .05 level

In addition to the results already mentioned, the girls in general appeared to have more significant correlations with reading scores than the boys, i.e., reading accuracy and Letter, Word, Sentence Total ($r = .35$ $p < .05$) and reading comprehension and Body Directionality ($r = .38$ $p < .01$). This apparent tendency for the girls to

have significant correlations between reading and directionality scores became even more pronounced after the I.Q. factor was partialled out. A possible explanation of this fact may be that for girls, at this level, learning tends to emerge as a more influential factor than for boys who appear to be more reliant upon a general intelligence factor. This same explanation may also be considered in terms of the significant correlations which were maintained between Sentence Directionality and reading accuracy for both boys and girls subsequent to the partialling out of I.Q.

In order to further analyse the relationship between directionality and reading achievement, an analysis of variance was carried out to determine if differences on directionality scores existed between the three reading groups. The data are shown in Table 9 and indicate significant differences over the Letter and Sentence Directionality scores ($p<.01$) but not over the Word scores (Table 9). This apparent lack of difference between the groups on the Word Directionality Test was not unexpected considering that the mean scores on this test were much closer than on any other test with no difference greater than 1.00 (i.e., 17.34, 17.05, and 16.35 respectively).

The differences between the high and average reading groups proved to be non-significant for both the Letter and Sentence Directionality tests (Table 10). However, significant differences were found between the high and low reading groups as well as the average and low reading groups over both of these directionality tests ($p<.01$ and $p<.05$ respectively). The major differences, therefore, appear to

TABLE 9

SUMMARY OF ANALYSIS OF VARIANCE ON LETTER, WORD, SENTENCE DIRECTIONALITY SCORES OVER HIGH, AVERAGE AND LOW READING GROUPS

Test	Source of Variance and Sums of Squares		Mean Squares		df		F
	Among Means of Total Scores	Within Scores	Among Means of Total Scores	Within Scores	Among Means of Total Scores	Within Scores	
Letter	21.70	129.95	10.85	2.28	2	57	4.76*
Word	10.53	248.05	5.27	4.35	2	57	1.21
Sentence	302.70	506.91	151.35	8.89	2	57	17.02*

*Significant at the .01 level

exist between the upper two reading groups (i.e., high and average) on one hand, and the low reading group on the other. Further, these differences appear to be most highly accentuated over the Sentence Directionality scores. Thus, it appears that differences between higher and lower reading achievers in their ability to discriminate directionality are most evident in their performance within the actual context of a sentence. Reading group differences over directional discrimination in isolation (letters) also proved to be significant, but to a lesser degree ($p<.05$), while discrimination within the context of words proved to be non-significant.

TABLE 10

THE SCHEFFE COMPARISON OF MEANS ON LETTER AND SENTENCE DIRECTIONALITY SCORES OVER HIGH, AVERAGE, AND LOW READING GROUPS

Directionality Tests	READING GROUPS		
	1-2	1-3	2-3
Letter	-	.05	.05
Sentence	-	.01	.01

- not significantly different at the .05 level
.05 significantly different at the .05 level
.01 significantly different at the .01 level
High (1) Average (2) Low (3)

The apparent greater differences between the groups evident on Sentence Directionality Test may possibly be a function of the nature of the task required. The children were originally stratified on the

basis of their reading accuracy ability. Since the Sentence Directionality Test requires the child to discriminate directionality within the context of a sentence it may be considered to more closely approximate the situation and abilities required for accurate word identification. Thus, it would appear to follow that those children who have attained a higher level of reading accuracy would also be more capable of directional discrimination within the same context, namely, sentences. These same differences, however, may not be as evident with isolated letters or within the context of nonsense words as has been demonstrated by the foregoing data. In conclusion, therefore, it may be considered that the best method for evaluating a child's directional discrimination ability would be through the use of an instrument which most closely approximates the actual reading situation, i.e., a sentence type discrimination test.

II. TIME AS A FACTOR IN DIRECTIONAL DISCRIMINATION ABILITY

Annand (1971), in a previous study, suggested that her tests pertaining to directional ability of letters may have been of greater diagnostic value if they had been timed. In keeping with Annand's observation, the present directionality tests were timed. The following is an analysis of these time scores.

As indicated in Table 11, the mean and standard deviation scores for the test times tend to follow fairly consistent progressions increasing from Letter to Sentence Directionality and from high to low reading groups. The total time scores also suggest a similar

increase in times from the high to the low reading achievement group.

TABLE 11

MEANS AND STANDARD DEVIATIONS OF DIRECTIONALITY TEST TIMES OVER HIGH, AVERAGE AND LOW READING GROUPS

			DIRECTIONALITY TESTS			
			Letter	Word	Sentence	Total
Reading Achievement Groups	High	$\bar{X}$	109.90	157.95	283.65	551.50
		S.D.	28.13	36.90	70.47	107.69
	Average	$\bar{X}$	122.40	180.55	322.85	625.80
		S.D.	25.14	40.49	104.29	140.90
	Low	$\bar{X}$	144.55	226.20	394.80	755.55
		S.D.	39.45	71.05	108.17	164.30

When the correlations between the directionality test times and directionality test scores are considered, there appears to be no significant correlations over the average and low group as well as the high group on Letter Directionality (Table 12). Significant correlations for boys, girls, and for total group were established between all the directionality test times and scores obtained on those same tests. The girls' group tended to attain higher correlation coefficients which seems to have resulted from a general tendency for the girls to work more slowly than the boys (i.e., total directionality times - $\bar{X}$ - 647.20, S.D. - 132.63 and $\bar{X}$ - 641.37, S.D. - 188.13 for girls and boys respectively) and to achieve higher scores on the Directionality tests.

TABLE 12

CORRELATIONS BETWEEN DIRECTIONALITY TEST TIMES AND SCORES OVER SEX, READING AND TOTAL GROUPS

		Directionality Test Scores					
		Sex		Reading Group			
		Boys	Girls	High	Average	Low	Total
DIRECTIONALITY TEST TIMES	Letter	-.40*	-.36*	-.07	.19	-.32	-.38**
	Word	-.47**	-.67**	-.47*	-.28	.30	-.53**
	Sentences	-.41*	-.54**	-.49*	-.07	-.01	-.46**
	Total	-.50**	-.66**	-.50*	-.10	-.30	-.56**

*Significant at .05 level

**Significant at .01 level

The relationship between the time taken to complete the directionality tests and reading achievement scores was also investigated. The data outlined in Table 13 indicate the relationship between reading scores and directionality test times. All of the obtained negative correlation coefficients established between reading scores and test times were found to reach a level of significance ($p<.05$, $p<.01$). These results tend to suggest that the facility and speed with which a child is able to discriminate directionality is also related to his/her level of reading achievement.

TABLE 13

CORRELATIONS BETWEEN DIRECTIONALITY TEST TIMES AND READING ACHIEVEMENT

	DIRECTIONALITY TEST TIMES			
Reading Factor	Letter	Word	Sentence	Total
Reading Accuracy	$-.38^{**}$	$-.54^{**}$	$-.46^{**}$	$-.56^{**}$
Reading Comprehension	$-.27^{*}$	$-.45^{**}$	$-.38^{**}$	$-.47^{**}$

** Significant at the .01 level

* Significant at the .05 level

An analysis of variance, as outlined in Table 14, indicates significant differences exist between the reading groups over the times established for the directionality tests ($p<.01$).

TABLE 14

SUMMARY OF ANALYSIS OF VARIANCE ON LETTER, WORD, SENTENCE DIRECTIONALITY TEST TIMES OVER HIGH AVERAGE AND LOW READING GROUPS

Test	Source of Variance and Sums of Squares		Mean Squares		df		F
	Among Means of Time Scores	Within Scores	Among Means of Time Scores	Within Scores	Among Means of Time Scores	Within Scores	
Letter	12316.63	56603.63	61858.31	993.05	2	57	6.20*
Word	48351.00	152936.00	24175.50	2683.09	2	57	9.01*
Sentence	127118.00	523292.00	63559.00	9180.56	2	57	6.92*

*Significant at the .01 level

The source of the differences is indicated in Table 15. The major source of group differences appears to stem from between the high and low reading groups. These differences reached the level of significance over time scores on all three directionality tests - Letter, Word, Sentence Directionality. Only on the Word Directionality Test was a level of significance reached between the average and low reading group ($p<.05$). On none of the other measures did the differences between groups reach a level of significance.

TABLE 15

THE SHEFFE COMPARISON OF MEANS ON LETTER, WORD, SENTENCE DIRECTIONALITY TIMES OVER HIGH, AVERAGE AND LOW READING GROUPS

Directionality Tests	READING GROUPS 1-2	1-3	2-3
Letter	-	.01	-
Word	-	.01	.05
Sentence	-	.01	.05

- not significantly different at the .05 level
.05 significantly different at the .05 level
.01 significantly different at the .01 level
High (1) Average (2) Low (3)

These results then would appear to suggest that time is a possible factor in a child's ability to discriminate directionality. A possible explanation may be that the higher, and, to a lesser degree,

the average groups have attained a greater facility in dealing with directionality. The lower group, on the other hand, may possibly be spending more time due to their lack of facility in the discrimination of directionality. Thus, it appears that the lower reading achiever not only tends to experience greater difficulty with directional discrimination, but he also, apparently, spends a greater amount of time in his attempts to discriminate.

III. ANALYSIS OF DIRECTIONAL ERROR TYPES

Previous studies (Smith, 1970; Annand, 1971) in this area have tended to examine directionality only in terms of a left-right dimension. The present directionality tests have been specially constructed so that an analysis of left-right, up-down, and front-back dimensions may be made for the Body Directionality Test, while left-right, vertical and combination dimensions may be examined for the Letter, Word, and Sentence Directionality tests.

The frequencies and types of directionality errors made on all four directionality tests - Body, Letter, Word, and Sentence, are outlined in Table 16. The greatest number of errors, for all tests, appears to be quite clearly on the left-right dimension. The second greatest number of errors on Letter, Word, and Sentence tests tend to be combination, while in the Body Directionality Test, the up-down dimension appears to rank second.

It should be noted, at this point, that direct comparisons between particular dimensional errors on the Body and Letter, Word,

TABLE 16

DIRECTIONALITY ERROR TYPES OVER HIGH, AVERAGE AND LOW READING ACHIEVERS

Test Groups	Directional Dimensions											
	Body			Letter			Word			Sentence		
	L-R	F-B	U-D	L-R	V	Comb.	L-R	V	Comb.	L-R	V	Comb.
High	36	0	4	12	0	0	30	17	2	54	19	5
Average	55	6	22	7	2	0	44	6	5	64	19	11
Low	70	6	30	19	2	1	48	8	13	93	35	31

L-R - Left-Right
F-B - Front-Back
U-D - Up-Down
V - Vertical
C - Combination

Sentence tests, other than the left-right dimension, must be limited in scope due to the three and two dimensional natures of the respective tests. However, gross directional abilities and particular dimensional abilities may be examined where feasible.

A one-way analysis of variance was used in order to establish whether there were differences between the reading groups on the types of errors they made. Table 17 presents the data obtained from an analysis of variance of dimensional errors made in the Letter, Word and Sentence tests over the three reading achievement levels. The vertical and combination errors for the Letter test were not further analyzed due to an obvious lack of variance within the groups.

Significant differences between the groups were found on all three directional dimensions within the Sentence test, while no significant differences were established within the Letter test. Combination errors on the Word test were significantly different ($p<.01$) for the various reading groups.

The high and low group differed significantly on the frequency of combination type errors on both Word and Sentence tests as well as left-right and vertical errors on the Sentence test (Table 18). The average group differed significantly from the low group in terms of vertical (i.e., for letters such as t-f, b-p) and combination (i.e., n-u, d-p) errors on the Sentence test and only combination errors on the Word test. Differences between the average and high groups did not reach a level of significance.

TABLE 17

SUMMARY OF ANALYSIS OF VARIANCE ON TYPES OF DIRECTIONAL ERRORS OVER HIGH, AVERAGE AND LOW READING ACHIEVERS

	Test and Directional Error	Source of Variance and Sums of Squares		Mean Squares		df		F
		Among Means of Total Scores	Within Scores	Among Means of Total Scores	Within Scores	Among Means of Total Scores	Within Scores	
Letter	L-R	3.63	52.30	1.82	.92	2	57	1.98
	L-R	8.93	149.00	4.47	2.61	2	57	1.71
Word	V	3.43	33.55	1.72	.59	2	57	2.92
	Comb.	3.23	16.10	1.62	.28	2	57	5.72*
	L-R	41.03	237.95	20.52	4.17	2	57	4.91*
Sentence	V	8.03	50.70	4.02	.89	2	57	4.52*
	Comb.	18.53	41.65	9.27	.73	2	57	12.68*

*Significant at the .01 level

TABLE 18

THE SHEFFE COMPARISON OF MEANS FOR TYPES OF DIRECTIONALITY ERRORS OVER HIGH, AVERAGE, AND LOW READING ACHIEVERS

Test and Directional Error	READING GROUPS 1-2	1-3	2-3
Word			
Combination	-	.01	.05
Sentence			
Left-Right	-	.01	-
Vertical	-	.05	.05
Combination	-	.01	.01

- not significantly different at the .05 level
.05 significantly different at the .05 level
.01 significantly different at the .01 level
High (1) Average (2) Low (3)

Thus, it would appear that lower achieving readers tended to make more directional discrimination errors on all three dimensions, than high achieving readers, and particularly when they were working within the context of a sentence. The differences between average and low readers also only became apparent when the task was completed within the context of a sentence, or in words when combination type errors were considered. It is also interesting to note that the average and low readers appear to display significant differences on

vertical and combination dimensions and not on a left-right dimension.

Further information concerning the types of errors made was obtained by calculating the proportions of each dimensional error made within a particular test. Table 19 outlines these proportions. As previously noted, the highest proportion of errors within all of the tests was on a left-right dimension. Although the left-right dimension does appear to cause the greatest amount of difficulty, it is interesting to note that the lower group displayed a tendency to have a greater distribution in error type proportions. This distribution became increasingly more obvious over Letter, Word, and Sentence tests as can be seen in Figures 1-3. Such a distribution of directionality types would seem to suggest that, whereas the higher reading achievers experience some difficulty with left-right discrimination, the lower achieving readers tended to display a more global deficiency in directional discrimination (i.e., all three dimensions).

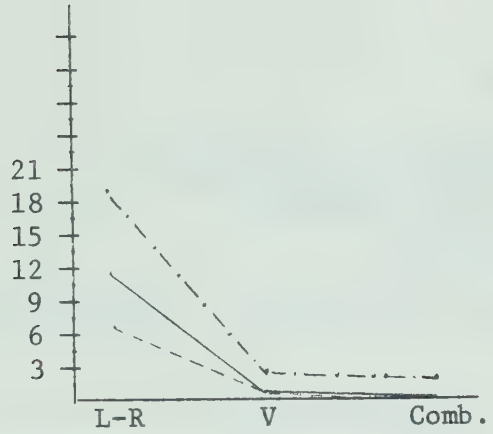
A z value was calculated in order to detect whether significant differences existed between the proportions. As indicated in Table 20, the proportion of left-right errors differs significantly from vertical and combination errors over Letter, Word, Sentence tests and over all three reading achievement levels ($p<.05$). These results further substantiate the focal role of left-right discrimination in directional ability. The only other significant difference between proportions of dimensional errors was found with vertical and combination errors in the high reading group on the Word test.

TABLE 19

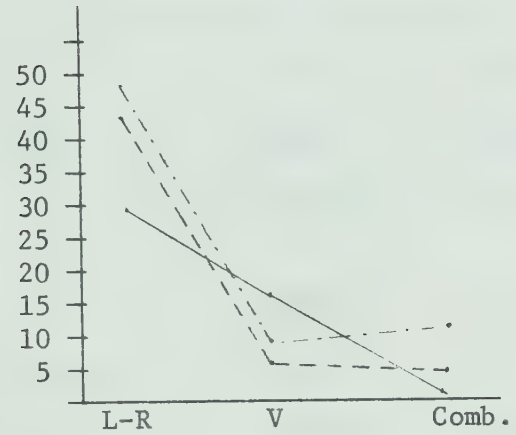
PROPORTIONAL DISTIRBUTION OF DIRECTIONAL ERROR TYPES OVER HIGH, AVERAGE AND LOW READING ACHIEVERS

		Body			Letter			Word			Sentence		
		L-R	F-B	U-D	L-R	V	Comb.	L-R	V	Comb.	L-R	V	Comb.
READING ACHIEVEMENT GROUPS	High	.90	.00	.10	1.00	.00	.00	.61	.35	.04	.69	.25	.06
	Average	.66	.07	.27	.78	.22	.00	.80	.11	.09	.68	.20	.12
	Low	.66	.06	.28	.86	.09	.05	.70	.12	.18	.58	.22	.20

L-R - Left-Right
F-B - Front-Back
U-D - Up-Down
V - Vertical
C - Combination



Letter Directionality



Word Directionality

High - _____

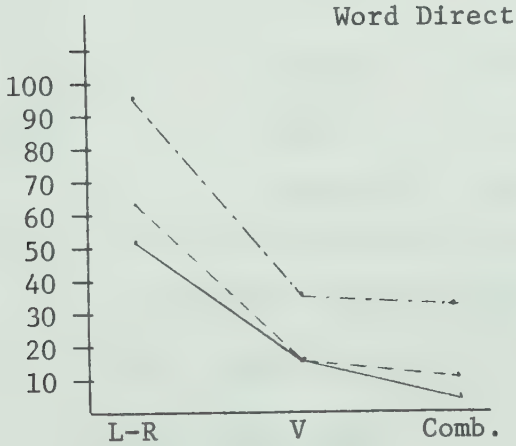
Average - --------

Low - -.-.-.-.-.-.

L-R - Left-Right

V - Vertical

Comb. - Combination



Sentence Directionality

Figs. 1-3. NUMBER OF ERRORS MADE BY HIGH, AVERAGE AND LOW READERS ON THE LETTER, WORD AND SENTENCE DIRECTIONALITY TESTS

TABLE 20

SIGNIFICANCE OF DIFFERENCES BETWEEN PROPORTIONS OF DIRECTIONALITY ERROR TYPES ON LETTER, WORD, AND SENTENCE TESTS OVER HIGH, AVERAGE AND LOW READING ACHIEVERS

		DIRECTIONAL DIMENSIONS		
Reading Groups	Test	LR-V	LR-Comb.	V-Comb.
High	Letter	.05	.05	-
	Word	.05	.05	.05
	Sentence	.05	.05	-
Average	Letter	.05	.05	-
	Word	.05	.05	-
	Sentence	.05	.05	-
Low	Letter	.05	.05	-
	Word	.05	.05	-
	Sentence	.05	.05	-

- not significant at the .05 level

.05 significant at the .05 level

L-R - Left-Right

V - Vertical

Comb. - Combination

A very similar pattern to the foregoing was established on the dimensional errors made within the Body test (Table 21), namely, significant differences were shown to exist between left-right / front-back, and left-right / up-down errors ($p<.05$). However, for the average and low reading groups, the differences between front-back and up-down errors, though apparently high, only approached the significance level ($p<.07$).

TABLE 21

SIGNIFICANCE OF DIFFERENCES BETWEEN PROPORTIONS OF BODY DIRECTIONALITY ERROR TYPES OVER HIGH, AVERAGE AND LOW READING ACHIEVERS

Test Groupings	DIRECTIONAL DIMENSIONS		
	L.R.-F.B.	L.R.-U.D.	F.B.-U.D.
High	.05	.05	-
Average	.05	.05	-
Low	.05	.05	-

- not significant at the .05 level

.05 significant at the .05 level

IV. DISCRIMINATION AND RELATED VARIABLES

Previous studies (Harris, 1957; Silver and Hagin, 1960; Coleman and Deutsch, 1964; Belmont and Birch, 1965) have raised the question of a relationship between directional discrimination and I.Q.

Directional discrimination in the foregoing studies, however, has always been in reference to the individual's body and on a left-right dimension. It has been hypothesized in this study that body referred directional ability precedes directional discrimination of objects in space, and, in particular, alphabetic letters. The present section therefore, will consider the relationship of I.Q. and directional discrimination ability as well as the possible hierarchical development of this ability. Finally, the relationships between the various tests of directionality will be examined.

Directionality and I.Q.

The SRA Primary Abilities, as described in Chapter III, offers an individual measurement for each of the primary abilities - Verbal Meaning, Perceptual Speed, Spatial Relationship, and Number Facility, as well as a single total estimate of general intelligence. Table 22 presents the correlation coefficients established between the general intelligence measure, the individual primary abilities, and the directionality tests. With the exception of the correlation between general intelligence and Word Directionality scores, the correlations between total I.Q. and the remaining directionality tests seem to be somewhat higher than those established between individual primary abilities and directionality tests. This tendency may be viewed as a possible indication of a further ability - directional discrimination ability - which appears to be more highly related to a general intelligence factor than to any of the individual abilities already being measured by the test.

TABLE 22

CORRELATIONS BETWEEN SRA PRIMARY ABILITY SCORES AND DIRECTIONALITY TEST SCORES

		DIRECTIONALITY TESTS			
		Body	Letter	Word	Sentence
S.R.A. Primary Abilities Factors	Verbal Meaning	.40**	.31**	.14	.43**
	Perceptual Speed	-.04	.50**	.16	.17
	Spatial Relationship	.30**	.45**	.10	.36**
	Number Facility	.28*	.30**	.18	.43**
	Total I.Q.	.33**	.52**	.20	.55**

Significant at the .01 level**

Significant at the .05 level*

No significant correlations were found between any of the primary mental abilities and the Word Directionality Test. The Perceptual Speed subtest displayed the least amount of correlation, with the directionality measures reaching a level of significance only with Letter Directionality. However, this correlation with the Letter test appears quite plausible since both tests involve a matching to sample of figures (i.e., geometric and pictures vs. alphabetic letters) in isolation. It is also interesting to note that the children in this sample tended to score above their C.A. level on the Perceptual Speed subtest which is also a visual discrimination test. However, generally low correlations between the Perceptual Speed test and the directionality tests would seem to indicate that somewhat different perceptual discrimination factors are involved.

Further, the correlation between Perceptual Speed and reading accuracy also tended to be rather low ($p<.09$)* while a much higher correlation existed between reading accuracy and the directionality test scores ($p<.01$) and, in particular, the Sentence test ($p<.01$).

The correlation coefficients between the remaining primary ability factors and the directionality tests reached the same level of significance ($p<.01$).

Body Directionality and Letter, Word, Sentence Directionality

As suggested in the review of literature, directional discrimination using a body referent point, was considered a basic

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*See Appendix B for complete data

directional ability. Table 23 outlines the correlations between the Body Directionality Test and the Letter, Word, and Sentence Directionality tests as well as their combined totals. In terms of the total sample, correlations between the Body test and the remaining directionality tests reached a level of significance in every incidence. Also, all the correlations between the Body test and the Letter, Word, and Sentence total score over boys, girls, average and low groups also reached levels of significance ($p<.05$, $p<.01$). These results tend to support the concept of a general directional ability factor in both modes of directional discrimination.

Body Directionality was also significantly correlated with Word and Sentence scores for the boys and for the low reading group, while significant correlations were established with Sentence scores for the girls' group.

Subsequent partialling out of I.Q. from the foregoing correlations did not drastically alter the established pattern (Table 24). With the exception of the Letter scores, the correlations between the Body test and Word, Sentence, as well as Letter, Word, Sentence Total for the total group remained at significant levels ($p<.05$, $p<.01$). Correlations between Body Directionality and Letter, Word Sentence total scores for girls and average and low reading groups also remained at a level of significance ($p<.05$). These results tend to substantiate the concept of a general directional discrimination ability which does not appear to be merely a function of general intelligence, but rather, to a substantial extent, a

TABLE 23

CORRELATIONS BETWEEN BODY DIRECTIONALITY SCORES AND LETTER, WORD, SENTENCE AND TOTAL SCORES OVER TOTAL SEX AND READING ACHIEVEMENT GROUPS

		Letter	Word	Sentence	Total
BODY DIRECTIONALITY	Total	.28*	.40**	.42**	.49**
	Boys	.27	.45**	.37*	.49**
	Girls	.35	.30	.45**	.48**
	High	.17	.07	.05	.05
	Average	.07	.42	.33	.47*
	Low	.43	.47*	.48*	.58**

*Significant at the .05 level

**Significant at the .01 level

TABLE 24

CORRELATIONS BETWEEN BODY DIRECTIONALITY SCORES AND LETTER, WORD SENTENCE AND TOTAL SCORES OVER TOTAL, SEX AND READING ACHIEVEMENT GROUPS WITH I. Q. PARTIALLED OUT

		Letter	Word	Sentence	Total
BODY DIRECTIONALITY	Total	.19	.35**	.28*	.37**
	Boys	-	.37*	.18	.33
	Girls	-	-	.35*	.39*
	Average	-	-	-	.44*
	Low	-	.45*	.41	.52*

*Significant at the .05 level

**Significant at the .01 level

function of learning. However, Letter and Word directional discrimination would appear to be more dependent upon an I.Q. factor considering that the correlation between these tests and reading achievement becomes non-significant when I.Q. is partialled out.

The highest correlation coefficients for any single sub-group appeared to be with the low readers. A possible explanation of this phenomenon would appear to lie in the fact that as a group they tended to show the greatest amount of directional confusion over both subjective and objective directionality modes. The remaining groups, however, although they tended towards total proficiency in Body Directionality, they appeared to experience comparatively greater difficulty with the objective directionality involved in the Letter, Word, and Sentence tests. Thus, it would seem that subjective and objective directional discrimination abilities tend to be hierarchical in the nature of their development.

Significant correlations between Body Directionality scores and Word Directionality for boys and Sentence Directionality for girls were also observed subsequent to the partialling out of I.Q.

Intercorrelations of Directionality Tests

Correlations between the four directionality tests were computed in order to obtain a measure of the internal consistency of these directionality tests. The correlation coefficients and their levels of significance are shown in Table 25.

All of the directionality tests which were constructed for

this study reached the criterion level of significance ($p<.05$) although none of the intercorrelations are exceedingly high. The fact that the correlations were both positive and significant would suggest the existence of a common factor - directional discrimination. However, the lack of exceedingly high correlation coefficients would also indicate that each test is measuring something different.

TABLE 25

CORRELATIONS BETWEEN
DIRECTIONALITY TESTS

	Body	Letter	Word	Sentence
Body		.28*	.40**	.42**
Letter			.41**	.49**
Word				.52**
Sentence				

Significant at the .01 level**
Significant at the .05 level*

The correlation coefficients between Sentence and Body, Letter, Word, show a gradual progression which tends to support the view that these tests are hierarchical in terms of difficulty.

These data, therefore, would tend to suggest that the Sentence Directionality Test may possibly be the most meaningful instrument for the measurement of directional discrimination.

V. SUMMARY

The mean scores obtained on all the directionality tests indicate a progression from the low to the high achieving readers. A similar progression was evident in the times taken to complete the Letter, Word, and Sentence tests. That is, the high reading achievers completed the test in the least amount of time while the low achieving readers required the longest time.

The ability to discriminate directionality in terms of one's own body and with reference to alphabetic letters in isolation, words and sentences, appeared to be positively correlated with reading accuracy achievement at the grade one level. Although all the tests were positively correlated with reading accuracy, the Sentence Directionality Test displayed the highest degree of such correlation. This correlation remained at a significant level after I.Q. was partialled out. It was, therefore, concluded that in terms of directional discrimination ability, the Sentence Directionality Test was the best predictor of success in reading.

An analysis of variance showed that significant differences existed between the high-low and average-low reading groups on scores obtained on both the Letter and Sentence Directionality test.

A time factor was investigated to determine its relationship to directionality scores and to reading achievement. Test findings subsequently showed that significant negative correlations existed between directionality test times and both reading achievement and

directionality scores, over the total group. Also, significant differences emerged between the high and low reading groups over times taken to complete the Letter, Word, and Sentence Directionality tests. Thus, it would appear that the low readers tend to be less accurate in the discrimination of directionality and also require more time to complete the task.

Left-right directional confusion appeared to account for the largest number of errors. However, significant differences between the high and low reading groups were apparent on all three dimensions (i.e., left-right, vertical, combination) on the Sentence Directionality Test. An analysis of the proportion of errors further indicated that the lower reading group displayed a greater tendency for global directional confusion, while the errors made by the higher reading groups tended to focus more on a left-right gradient.

The correlations established between the Letter Directionality Test scores and the total I.Q. score, as well as the component primary ability subtests all reached a level of significance ($p<.01$). These results would seem to suggest that I.Q. is a major factor in the child's performance on the Letter Directionality Test.

The present data also showed that the correlations between Body Directionality Test scores and the Letter, Word, Sentence, Directionality test scores reached a level of significance over the total group ($p<.05$). These data appears to suggest that the extent of directional discrimination ability in subjective space (i.e., directionality in reference to one's own body) is indicative of success in

objective space (i.e., alphabetic letters in isolation, words and sentences).

Finally, intercorrelations among the directionality test scores indicated significant correlations for all the test combinations. The correlation coefficients, though significant, were not exceedingly high. The nature of the correlations, however, tended to substantiate a hierarchical arrangement of test difficulty , ranging from Body Directionality to Sentence Directionality.

The following chapter will contain a summary of this study, discussion of the hypotheses, possible implications, and suggestions for further research.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

I. SUMMARY

The main purpose of this study was to investigate the ability to discriminate directionality over three dimensions (i.e., left-right, up-down, front-back) and its relationship to the beginning stages of reading achievement. The childrens' ability to discriminate directionality in both subjective (body referent) and objective (alphabetic letters) space was assessed. The body dimensions involved left-right, up-down, and front-back, while the letters were transformed over left-right, vertical and a combination of these dimensions. A sample of grade one readers of at least average I.Q. was chosen with equal distributions over sex and reading ability. The total sample, therefore, involved groups of thirty boys and girls with ten high, average and low achieving readers in each group.

II. FINDINGS AND CONCLUSIONS

Hypothesis 1

There is no significant correlation between scores on the Neale Analysis of Reading Ability and:

(a) Scores on the Body Directionality Test

(b) Scores on the Letter Directionality Test

(c) Scores on the Word Directionality Test

(d) Scores on the Sentence Directionality Test

(a) This hypothesis was rejected for both reading accuracy and reading comprehension scores over the total sample. Further, when the I.Q. factor was partialled out, the correlation between Body Directionality and reading comprehension remained at a level of significance ($p<.05$) while the relationship with reading accuracy fell below the .05 level of significance. In terms of high, average, and low reading achievement groups this hypothesis was not rejected since none of the correlations reached the .05 level of significance. This hypothesis was also not rejected for the boys' group, but was rejected for the girls. When I.Q. was subsequently partialled out, only the reading comprehension scores of the girls retained a significant correlation with Body Directionality.

(b) This hypothesis was not rejected for any of the correlations established with the reading comprehension scores. The hypothesis was only rejected over reading accuracy scores in reference to the total group as well as the boys' and girls' groups. However, when I.Q. was partialled out the given hypothesis was not rejected for any of the groupings.

(c) This hypothesis was not rejected for any of the groupings on either the reading accuracy or reading comprehension measures.

(d) This hypothesis was rejected for both reading accuracy and reading comprehension scores over the total group. The subsequent partialling out of I.Q. gave further evidence to support rejection of this hypothesis since a significant correlation at beyond the .05 level existed between Sentence Directionality and reading scores. The given

hypothesis was not rejected in reference to the high, average, and low reading groups. Also, although the hypothesis is generally rejected over boys' and girls' groupings, it was not rejected with reference to the boys' comprehension scores subsequent to the partialling out of the I.Q. factor.

Conclusion

The test results suggest that Body Directionality scores tended to be more highly related to reading comprehension than reading accuracy. In view of the nature of the test administration (i.e., response to an oral directive), it would seem that the child's ability to comprehend the oral directives of the Body Directionality Test is related to his ability to comprehend the written language of the Neale Analysis of Reading. Both the Letter and Word Directionality tests appear to have little or no relationship with reading achievement scores. The relationships that were found to exist between Letter Directionality and reading scores seem to have been highly influenced by an I.Q. factor, since, when this factor was subsequently partialled out, none of the correlations over the various groups reached the .05 level of significance.

The Sentence Directionality Test appears to have maintained the highest and most consistent level of correlation with reading achievement scores over the various sample groupings. It would seem, therefore, that a child's level of reading achievement is most highly related to his/her ability to discriminate the directionality of alphabetic letters when they are placed within the context of a sentence.

Hypothesis 2

There is no significant difference between the scores obtained by high, average,and low reading achievers on:

(a) Letter Directionality Test

(b) Word Directionality Test

(c) Sentence Directionality Test

(a) This hypothesis was rejected since the analysis of variance indicated that the high, average, and low reading groups differed significantly in their Letter Directionality scores. A Sheffe comparison of the means revealed that both the high and average groups performed significantly ($p<.05$) better than the low reading achievers. However, the high group did differ, at the .05 level, from the average group on Letter Directionality scores.

(b) This hypothesis was not rejected since the high, average, and low reading groups did not differ significantly in their performance on the Word Directionality Test.

(c) This hypothesis was rejected since the high, average, and low reading groups differed, beyond the .01 level of significance, in their Sentence Directionality scores. A Sheffe comparison of the group means further indicated that the high and average groups performed significantly ($p<.01$) better than the low reading achievement group, whereas the high and the average reading achievers did not differ at the .05 level of significance.

Conclusion

The present data tend to indicate that the ability to

discriminate the directionality of alphabetic letters appears to be a distinguishing factor in differentiating particularly between low reading achievers and those who are of average or high reading ability. These results further suggest that this apparent deficiency in directional discrimination ability displayed by the low reading group may be a contributing factor to their lack of reading success.

The results on the Word Directionality Test seem to indicate that this particular test is possibly an inadequate instrument for measuring differences in directional discrimination ability with grade one children. Results from the previous hypothesis tend to substantiate the foregoing in that no significant correlations were established between reading achievement scores and Word Directionality results. Although scores obtained on the Letter Directionality Test showed significant differences between the high and low as well as the average and low reading groups, these same groups differed to a much greater degree in their performances on the Sentence Directionality Test. It would thus appear that the Sentence Directionality Test is the best of the directionality instruments for measuring differences between the ability of grade one children, at this stage, to discriminate the directionality of alphabetic letters.

Hypothesis 3

There is no significant correlation between times taken on the Letter, Word, and Sentence Directionality tests and

(a) Scores on the Letter, Word, and Sentence Directionality tests

(b) Scores on the Neale Analysis of Reading Ability

(a) This hypothesis was rejected over both boys' and girls' groups as well as the total sample since significant negative correlations existed between directionality test times and directionality test scores. Correlations between test scores and times on the Word and Sentence Directionality tests also reached the .05 level of significance for the high reading group, whereas the correlation between these same factors on the Letter Directionality Test did not reach a level of significance. On the basis of non-significant correlations over the average and low reading groups the hypothesis was not rejected.

(b) This hypothesis was rejected since significant negative correlations were revealed between Letter, Word, and Sentence Directionality test times and both reading accuracy and reading comprehension scores.

Conclusion

These results tend to suggest that the time required by a child to discriminate the directionality of an alphabetic letter is, to a degree, related to his/her ability to discriminate accurately. Thus, it would follow that a child who requires more time to discriminate the directional orientation of an alphabetic letter tends to be more likely to make inaccurate discriminations. It was further shown that the time required to discriminate the directionality of an alphabetic letter is related to a child's reading achievement level. These results would suggest, therefore, that a child who requires a greater length of time to discriminate the directional orientation of an alphabetic letter would also experience greater difficulty in his/her

attempts to read accurately and with comprehension.

Hypothesis 4

There is no significant difference between times taken by high, average, and low reading achievers to complete the:

(a) Letter Directionality Test

(b) Word Directionality Test

(c) Sentence Directionality Test

(a), (b), (c) These hypotheses were rejected since significant differences were found between the time required by the high, average, and low reading achievers to complete the Letter, Word, and Sentence Directionality tests. A Sheffe comparison of the means on the various directionality tests revealed significant differences ($p<.01$) between the times taken by the high and low reading achievers on the Letter, Word, and Sentence Directionality tests. Differences between the average and the low reading achievers reached the .05 level of significance on only the Word and Sentence Directionality Tests. No significant differences were discovered between the times required by the high and average reading groups.

Conclusion

A pattern similar to that previously shown with directionality test scores seems to have emerged on directionality test times - namely, the greatest differences on times taken to complete a directionality test exist between high and low reading groups with no significant differences apparent between the high and average groups. Lesser, though

significant, time differences were established between the average and low reading groups on the Word and Sentence Directionality tests. Thus, it would appear that children who are low in reading achievement are also distinguishable from better readers by the greater amount of time they require to discriminate the directionality of alphabetic letters. The lack of difference between the high and average groups would seem to further suggest that the time required by the low group may be a greater handicap to the poorer reader than to the child considered to be an average reader.

Hypothesis 5

There is no significant difference between the types of errors made by high, average, and low reading achievers on the:

(a) Letter Directionality Test

(b) Word Directionality Test

(c) Sentence Directionality Test

(a) Errors on these tests were analysed in terms, left-right, vertical, and a combination of these dimensions. Since no significant differences were found between the types of errors made on the Letter Directionality Test by the high, average, and low reading achievers this hypothesis was not rejected.

(b) This hypothesis was rejected in terms of combination type errors but not rejected with reference to left-right and vertical type errors. A Sheffe comparison of the means indicated that differences between the high and low reading achievement groups, as well as

between the average and low reading achievement groups, on combination and vertical type errors, reached levels of significance ($p<.01$ and $p<.05$ respectively).

(c) This hypothesis was rejected since significant differences were found between left-right, vertical, and combination errors over high, average, and low reading achievers. A Scheffe comparison of means revealed that significant differences existed between the high and low as well as average and low reading achievers on all three dimensions. The sole exception of non-significant differences lay between the average and low reading groups on errors made over a left-right dimension.

Conclusion

The present data once again indicate that group differences appear to be greatest between the high and low readers, followed by the differences between the average and low readers, while non-significant differences tended to exist between the average and high readers. It would also seem from these results that the differences between the type of directionality errors made by children of various reading levels become more apparent on the Sentence Directionality Test. Thus, it appears that the lower achieving reader differs from achieving readers in that he/she tends to make more directional discrimination errors over all dimensions and this directionality deficiency is best measured using the Sentence Directionality Test.

Hypothesis 6

There is no significant correlation between scores on the

Letter, Word, and Sentence Directionality tests and:

(a) I.Q. scores

(b) Body Directionality Test scores

(a) In terms of correlations between I.Q. and Letter Directionality, this hypothesis was rejected for the total I.Q. scores and all the I.Q. subtest scores. No significant correlations were found between any of the I.Q. scores and the Word Directionality scores, therefore this hypothesis was not rejected. Since the correlations between the total I.Q. score as well as all the sub-test scores (except Perceptual Speed) and Sentence Directionality scores were statistically significant, the hypothesis may be considered rejected for them. In summary, therefore, this hypothesis can be rejected in part, depending upon which I.Q. sub-scores are being considered.

(b) This hypothesis was rejected in terms of Letter Directionality over the total sample; with reference to Word Directionality over the total, boys, and low reading groups; and finally, in terms of Sentence Directionality over the total, boys, girls, and low reading achievement groups, since significant correlations existed for these groups between the above directionality tests and Body Directionality. However, subsequent to the partialling out of a measure of I.Q., significant correlations between Body Directionality scores and Word Directionality scores remained for the total, boys, and low reading achievement groups, while significant correlations between Body Directionality and Sentence Directionality were found to exist over the total and girls' groups.

Conclusion

The current data pertaining to directionality scores and I.Q. seem to suggest that the factor measured by these directionality tests generally tends to be more highly related to a general intelligence measure than to any of the individual primary mental abilities, as measured by the SRA Primary Mental Abilities Test.

The one subtest (Perceptual Speed) which most closely resembles the present directionality tests (i.e., match to sample discrimination task), shows a minimal relationship to the Word and Sentence test scores. However, the rather high correlation between Perceptual Speed and Letter Directionality may be due to greater similarities between the two tasks (i.e., the discrimination of isolated figures - pictures and silhouettes versus alphabetic letters respectively). Thus, it would seem that the present directionality tests may be measuring a separate ability which, though related, is distinct from those found in the SRA Primary Abilities. Data would also seem to suggest that a child's performance on discriminating gross symbols (shapes, etc.) shows little relationship to his ability to discriminate letters embedded within words or sentences.

The ability of the child to discriminate directionality with reference to his/her own body tends to be related to his/her ability to discriminate directionality in terms of alphabetic letters. This general tendency is most apparent in terms of the performance of the total group. However, a further interesting pattern developed over the high, average, and low reading groups. The low reading achievers

tended to obtain higher correlation coefficients between Body Directionality and Letter, Word, and Sentence Directionality scores than the high reading achievers, while the average reading achievers tended to maintain an intermediate position. This phenomenon may be accounted for by the fact that the high reading group had basically mastered directionality using a body referent point. However, a comparable degree of mastery was not evident in dealing with alphabetic letters. The lower reading child, however, did not appear to have totally mastered directionality in reference to his own body, and this deficiency, it would seem, is also related to a deficiency in dealing with the directional orientation of letters. These results then tend to substantiate a hierarchical development of directional discrimination - namely, subjective (i.e., body referred) to objective (i.e., alphabetic letters).

III. LIMITATIONS OF THE STUDY

In addition to those limitations already outlined in Chapter 1, the following factors became apparent during the testing, which may tend to limit the applicability of the findings.

1. The average I.Q. for the total group ($\bar{X}$ - 110) was approximately ten points above the normative mean. Therefore, the sample involved in the present study may possibly be atypical in their level of general intelligence.

2. During the actual testing, the author noticed that a number of children tended to omit items. When this was observed,

the child was redirected to complete the particular item omitted. This behavior was only noticed on the Letter Directionality Test. Such departure from the standard method of test administration may have possibly introduced some bias in the test results.

IV. SUGGESTIONS FOR FURTHER RESEARCH

1. A follow-up study, using the present sample, may reveal further information with regard to the developmental aspects of directional discrimination ability. Such a study would possibly reveal whether directional discrimination is a factor in reading success at the grade two level. Annand (1971) suggested that by grade two an intelligence factor tended to compensate for a lack of left-right discrimination ability with reference to the body. Therefore, a future study may find it necessary to use tests which could measure a more advanced level of directional discrimination ability, in a manner much like the present Sentence Directionality Test.

2. A further study may possibly involve the establishment of a directionality training program in order to determine the efficacy of such remediation. Pre-tests would allow for specific focus in a remediation program in reference to subjective or objective directionality, as well as on definite dimensions. Subsequent post-tests may then reveal important information with regard to remediation in this area.

3. Research might be conducted which focussed more on the child's reading. Passages may be constructed with words containing

the letters used in the discrimination tests of this study and an analysis of the child's oral reading would determine if the errors made on the discrimination tests also occurred when the child was reading orally.

4. Research might be profitably conducted in order to determine whether the types of errors a child makes on a directional discrimination test (as used in this study) are reflected in his printing or writing.

V. IMPLICATIONS

1. The results of this study suggest that the low achieving reader differs from the more successful reader in his/her ability to accurately discriminate the directionality of alphabetic letters. Although the low achieving child tends to experience his/her greatest amount of difficulty in dealing with transformations on a left-right gradient (i.e., b-d), it is also apparent that he/she has a good deal more difficulty than the average or above average reader in discriminating letter transformations on a vertical dimension (i.e., b-p), as well as those on a combination of the former two dimensions (i.e., b-q). Thus, it would seem that those children experiencing difficulty in the discrimination of alphabetic letters would benefit from training in directional discrimination, not only on a left-right gradient, as suggested by Smith (1970) and Annand (1971), but also a vertical dimension as well as a combination of the two dimensions. Such a procedure may entail the simultaneous presentation, drawing or construction

of a letter along with its various dimensional transformations. The child could be directed to note the likenesses and differences between the various letter transformations. Particular attention would be given to those transformations which approximate or exactly match other legitimate symbols encountered in the reading process (i.e., m, w, 3, E; e, 6, 9; b, d, p, q; h, y; n, u, c, etc.).

In order to help a child become more efficient in discriminating letters, a further exercise may require the child to circle those letters in a given passage which matched a letter the teacher would present on a flash card.

If the child has difficulty in printing the letters (e.g., b-d) in the correct orientation, he may be taught to use his thumb as a stabilizer to orientate his printing. That is, his left hand may be placed flat on the desk (if he is right-handed), and his right hand used to make the letters. He should be taught four directions in relation to his thumb and to his body.

A: away from his body
B: towards his body
C: away from his thumb
D: towards his thumb

The teacher would say and do the actions with the child at the beginning and then gradually let him do them by himself. For example, to make a 'b' the steps would be:

a. make a line towards the body, and

b. a curve away from his thumb on the bottom half of the line.

To make a 'd' the steps would be:

a. make a line towards the body, and

b. a curve towards the thumb on the bottom half of the line.

2. The present results also suggest that those children who display a deficiency in discriminating directionality, with reference to their own bodies, also demonstrate a greater deficiency in the directional discrimination of alphabetic letters. The major source of body directional confusion appears to stem from a left-right dimension. However, sufficient confusion was apparent in the lower achieving child on both up-down and front-back dimensions to warrant consideration. Thus, it would appear that those children found to be experiencing difficulty in the directional discrimination of alphabetic letters should also be tested on their ability to discriminate directionality with reference to their own bodies. Suitable programs may then be initiated which would focus on the real needs of the child, considering the development of body directionality as an ability basic to the development of letter directional discrimination. Further, such body directionality programs would need to consider not only the more traditional left-right dimension but also training in discrimination of up-down and front-back.

A game such as "Simon Says" may be used to develop body directionality. In this game the child follows instructions which are prefaced by the words, 'Simon says'. Thus, an instruction may be "Simon says, put your left hand above your head".

3. Results of the study further indicate that children who tend to experience difficulty in discriminating the directionality of alphabetic letters also appear to require more time to complete such discrimination tasks. It would therefore seem that such children would benefit, not only from instruction in directional discrimination, but also from repeated forms of practice in order to better facilitate their ability to discriminate. Such a facility would in turn allow for a greater concentration on other central aspects of the reading process, namely, identification and comprehension.

In order to help develop greater facility in directional discrimination a time factor may be introduced into the exercise. Thus a child may be provided with some means of timing himself while completing a discrimination exercise. The subsequent time score could be recorded daily and used as a measure of progress. His record in completing discrimination exercises would be kept in relation to his own performance and no attempt would be made to compare his performance with other children.

Another exercise to increase speed is similar to the suggestion presented in the first implication. The child may be given a list of words containing letters which he tends to confuse with two words per line, for example 'ball - doll'. A letter (b) would be flashed and the child would be requested to circle the word containing that letter. This procedure could also be used with sentences.

Finally, in order to transfer this ability to a reading situation, he may be given a short passage with words containing letters

he confuses. He may be instructed to underline these letters with different colors, for example, blue for b, red for d, and then read the passage. The purpose of the underlining would be to help focus his attention on those letters he tends to confuse.

A somewhat similar exercise would be to give him a short passage with words containing confusable letters, for example 'b - d', but the letters have been omitted. The child would be instructed to read the passage, and on the basis of the meaning to insert the correct letter. The opening line of such a story might be "Tom saw a little -og on his way to school".

4. Since the inability to discriminate the directional orientation of letters within the context of sentences appears to be consistently related to a low level of reading achievement, it could therefore be readily used as a diagnostic instrument by the teacher or reading clinician in identifying a possible antecedent for an individual child's reading problem.

However, since the scores listed in this study are norms for a group, and since individual performance varied on the Letter and Word, as well as the Sentence Directionality Test, all three tests may prove of diagnostic value in a clinic situation.

5. There has been a certain amount of conflicting evidence regarding the efficacy of a test such as the Frostig Developmental Tests of Visual Perception in predicting reading achievement (Leibert and Sherk, 1970). Cohen (1969) maintains that most available visual perceptual instruments tend to be measuring behaviors related to

non-verbal I.Q. tests. He further contends that actual letters and words are more important factors. The present study tends to substantiate the foregoing hypotheses.

The Perceptual Speed subtest of the SRA Primary Mental Abilities revealed generally low correlations with the present directionality tests as well as the reading achievement scores. It would, therefore, appear, in view of the present research, that the discrimination of gross symbols and even isolated alphabetic letters, have rather poor predictive value for reading achievement at the current grade one level. However, the discrimination of letters within the context of a sentence does show rather high predictive value.

VI. CONCLUDING STATEMENT

This study included an analysis of grade one children's performance on directional discrimination tasks and the relationship of this performance to reading achievement.

Findings showed that the development of directional discrimination ability seems to be hierarchical in nature, beginning with the discrimination of directionality with reference to one's own body through to alphabetic letters in isolation, within words and finally within the context of a sentence.

Both the scores made on the Directionality tests and the time taken to complete them were found to be significantly related to reading achievement scores.

The low reading achievement group scored consistently below

the average and high reading achievers on all variables. Not only did the low achievers score consistently lower, but they also made a much greater proportion of different kinds of directional errors (i.e., left-right, vertical, and combination of both), as opposed to the average and high achievers who tended to make errors on the left-right dimension only.

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A P P E N D I X A

BODY DIRECTIONALITY TEST

LETTER DIRECTIONALITY TEST

WORD DIRECTIONALITY TEST

SENTENCE DIRECTIONALITY TEST

DIRECTIONS FOR THE BODY DIRECTIONALITY TEST

I am going to ask you to do certain things and I want you do do exactly what I say.

DIRECTIONS FOR THE LETTER, WORD AND SENTENCE DIRECTIONALITY TESTS

Put your finger on the first letter and find a letter just like this one. When you find it put a mark through it with your pencil.

Directions for the Word and Sentence tests were similar except 'word' and 'sentence' were substituted for 'letter'.

Body Directionality Test

Eyes Open

1. Put block behind back. _____
2. Put block above head. _____
3. Show left hand. _____
4. Put block below ear. _____
5. Touch left ear with left hand. _____
6. Put block in front of stomach. _____
7. Put block in front of knee. _____
8. Put block above foot. _____
9. Touch left eye with right hand. _____
10. Show left eye. _____
11. Put block above shoulder. _____
12. Put block in front of chest. _____
13. Put block behind head. _____
14. Put block below chin. _____
15. Touch right knee with right hand. _____

Eyes Closed

16. Put block behind knee. _____
17. Touch left knee with left hand. _____
18. Put block behind neck. _____
19. Put block above eye. _____
20. Show right hand. _____
21. Put block behind leg. _____
22. Put block below knee. _____
23. Put block below nose. _____
24. Touch right ear with right hand. _____
25. Put block in front of nose. _____
26. Touch right shoulder with left hand. _____
27. Put block below eye. _____
28. Put block in front of foot. _____
29. Show left leg. _____
30. Put block above ear. _____

NAME OF CHILD: _____

g	p	g	ɓ	j	ð
w	ɜ	ʍ	v	w	ɜ
q	g	d	p	q	b
f	ɬ	f	j	ɬ	ɬ
h	ɳ	ɥ	k	ɻ	h
u	ɹ	ɾ	u	m	ɳ
b	b	d	p	l	q
t	t	ʇ	ʃ	k	ɬ
y	ʏ	ʎ	ʎ	v	y
d	q	d	p	b	j
r	ɪ	c	ɪ	r	ɹ
ɳ	u	ɾ	ɳ	m	ɹ
h	h	ɻ	ɥ	k	ɳ
b	q	d	l	p	b
y	y	ʎ	v	ʎ	ʏ
f	ɬ	f	ɬ	j	ɬ
r	c	ɹ	r	ɪ	ɪ
d	q	j	b	d	p
ɳ	u	v	ɳ	ɹ	ɾ
t	ʃ	ʇ	ʃ	k	t
q	p	g	d	q	b
u	m	u	ɳ	ɹ	ɾ

ges	ɒes	pon	ð̞es	ges	ɓes
lem	leɛ	leɯ	lem	leɜ	kiz
weh	nib	weh	weɥ	werl	weɒ
bek	dek	laf	pek	bek	qek
yev	λev	ɣev	ʎev	ruj	yev
zef	zeɬ	suk	zef	zeɬ	zeɬ
rec	ɹec	vin	ɾec	rec	ɹec
ved	nog	vep	ved	veb	veq
leɳ	leɯ	leɳ	leɾ	kac	leɹ
tek	tek	ɬek	lud	ʔek	ɬek
geq	geq	ged	joh	gep	geb
jeɯ	jeɯ	jeɾ	jeɳ	zas	jeɹ
fedal	fedal	ɬedal	kelan	ʔedal	ɬedal
cevar	cenac	cevaɹ	cevaɪ	cevaɪ	cevar
meɯav	meɾav	recam	meɹav	meɯav	meɳav
jeyag	jeyag	jeɣag	jeʎag	jeλag	pejap
qejac	geyaj	qejac	dejac	bejac	pejac
gekab	gekap	gekaq	gekad	gekab	jetar
veɳam	veɹam	revac	veɯam	veɾam	veɳam
kehak	keɥak	kerlak	kehak	ledat	keɒak
dekal	telat	dekal	bekal	qekal	pekal
delat	delaf	delaɟ	delat	kedan	delaɬ

The water is cold.	The ᴍater is cold. The ɜater is cold. The water is cold. The ɛater is cold. The movie is over.
They found gold.	They found ɒold. They found ∂old. They found gold. They sound poor. They found ɓold.

The hen is white.	The man is right. The ɳen is white. The ɥen is white. The hen is white. The ƿen is white.
I wash in the tub.	I wash in the tup. I wash in the tuq. I wash in the tud. I work in the sea. I wash in the tub.
He is a good boy.	It is a hard toy. He is a good boy. He is a good boʎ. He is a good boɣ. He is a good boʌ.
The water is free.	The water is free. The water is ɬree. The water is ɟree. The paper is blue. The water is ƭree.

The car ɪs red.	The car is red. The car is ɹed. The tar is hot. The car is ɹed. The car is ɿed.
The dog is heavy.	The bog is heavy. The log is light. The qog is heavy. The dog is heavy. The pog is heavy.
It was an ant.	It was an aɹt. It ran to him. It was an aɾt. It was an ant. It was an aut.
Sit on the chair.	Siʔ on the chair. Sit in the shade. Sit on the chair. Siſ on the chair. Siʃ on the chair.
You walk quickly.	You walk buickly. You walk quickly. You walk puickly. You wait quietly. You walk duickly.
He is ʯp high.	He is ɳp high. He is ɹp high. He is at home. He is ɾp high. He is ʯp high.

Some roads are long.	Some roabs are long. Some roots are long. Some roads are long. Some roaps are long. Some roaqs are long.
They have nine cats.	They have more cats. They have niue cats. They have nirre cats. They have nire cats. They have nine cats.
The old tile is broken	The old tile is broken. The old file is broken. The old jile is broken. The old lile is broken. The old line is broken.
The bad boy ran home.	The dad boy ran home. The sad boy ran home. The bad boy ran home. The pad boy ran home. The qad boy ran home.
He likes to laugh.	He likes to lagrgh. He likes to laugh. He likes to langh. He likes to teach. He likes to larrgh.
The roof is leaking.	The root is leaking. The roof is leaking. The roof is leaking. The roof is leaking. The room is leaking.

A queen lives here.	A crane lives here.
	A dueen lives here.
	A pueen lives here.
	A queen lives here.
	A bueen lives here.
Mother held the baby.	Mothe held the baby.
	Martha held the baby.
	Mothe held the baby.
	Mother held the baby.
	Mothe held the baby.
The yard is green.	The yard is green.
	The ard is green.
	The ard is green.
	The card is green.
	The yard is green.
The wall is very high.	The wall is very high.
	The wall is very high.
	The wall is very hard.
	The wall is very high.
	The wall is very high.

A P P E N D I X B

CORRELATIONS BETWEEN

I. Q. AND READING ACHIEVEMENT

CORRELATIONS BETWEEN READING
AND I. Q. TOTAL AND SUBTEST SCORES

I. Q. Total and Subtest Scores

Reading Achievement	Verbal Meaning	Perceptual Speed	Number Facility	Spatial Relations	Total I. Q.
Reading Accuracy	.37*	.22	.39*	.33*	.46*
Reading Comprehension	.45*	.20	.44*	.32*	.48*

*significant at the .01 level